

How the Flying Was Done in 'Air Force One'

# AIR & SPACE

Smithsonian

**Suit  
UP!**

**What to Wear  
in Space  
This Summer**

**Treasure Map  
of Edwards  
Air Force  
Base**

**Putting  
Together  
the Puzzle  
of TWA 800**

SEPT 1997 • \$3.95 U.S./\$4.50 Canada





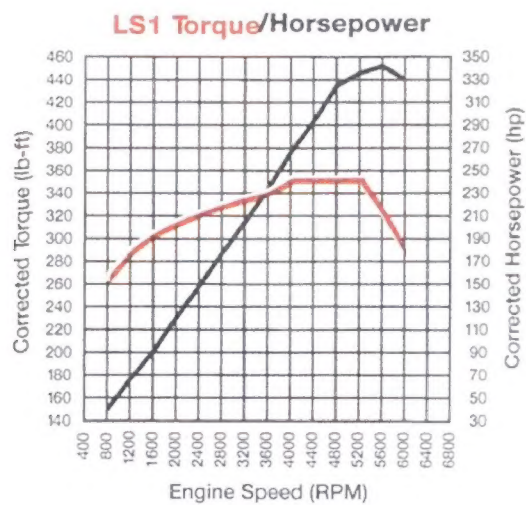
{The honest-to-goodness truth}

# The inordinate di

By David Hill, C

In engineering, generally, the simplest solution is almost always the most effective: the most efficient, the strongest and the lightest.

When we designed and engineered the C5 Corvette, we developed simple solutions by using a systems engineering philosophy: That is, thoughtfully define the requirements, and then design to meet those requirements. Doing so led us to solutions that, simply put, enabled us to deliver a better sports car.



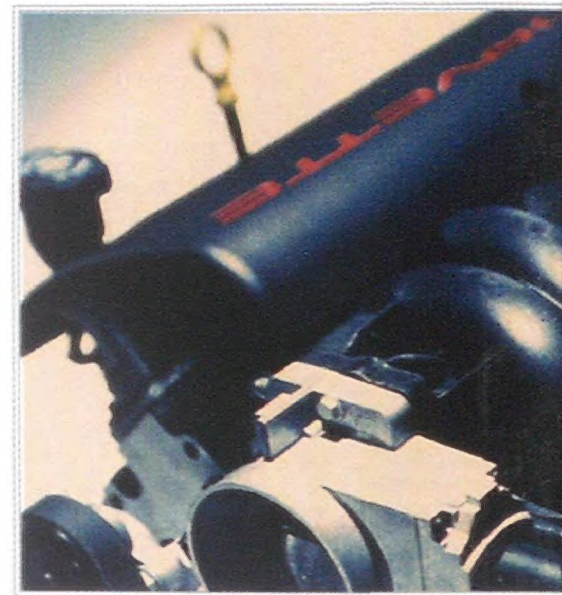
{ The engine is entirely new: aluminum, deep-skirt, 5.7L, }  
{ 345 hp at 5600 rpm, 350 ft.-lbs. of torque at 4400 rpm. }

Air goes faster in a straight line. We asked ourselves, "What is a Corvette power plant fundamentally supposed to do?" It's supposed to have instantaneous throttle response to develop 345 horsepower and to get 18 city/28 hwy mpg. This engine design accomplishes these goals because it has lots of cubic inches and doesn't have to be brought up to high rpm in order to start producing its output. The new engine is ported like an overhead cam motor. Instead of curving around the pushrod, the air follows a straight path to the combustion chamber. This gave us better breathing, better efficiency and thus, more power.

It is also a very compact engine. Put it next to a 3-liter twin-turbo V6 with four cams and you'll see what I mean. That compactness allows us to make the C5's hood low for better aerodynamics. Plus, you don't have a high hood to look over or windshield wipers that are overly prominent.

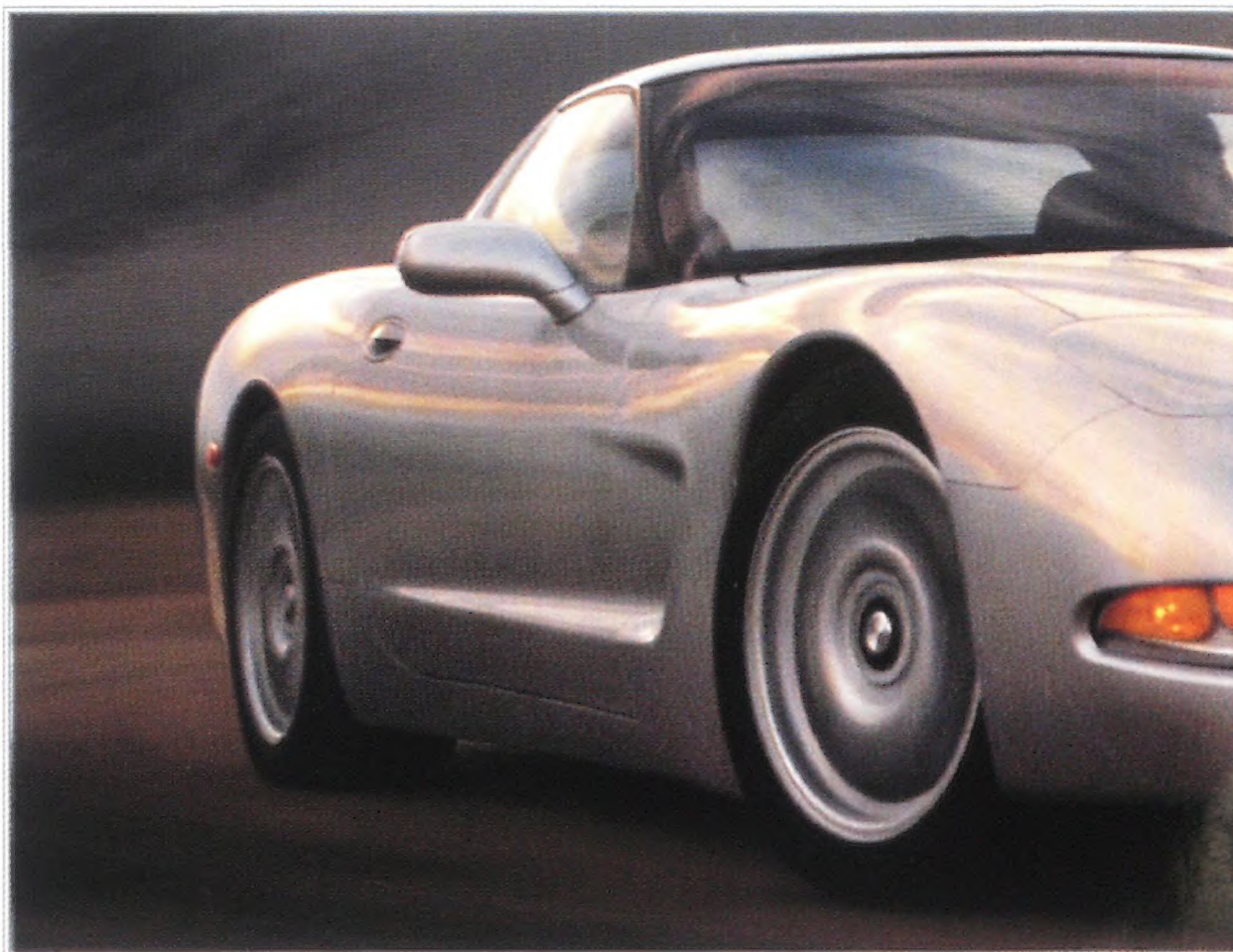
It all starts on the ground floor. The same systems engineering approach led us to develop a balsa wood, cored composite floor. Typically, you'd find cored composites in sport airplanes or racing boats. This, I believe, is the first time that cored-composite technology has been applied to a production sports car.

In the case of the C5 Corvette, the cored composite is balsa sandwiched between thin layers of glass-reinforced polyester. We elected to use balsa after examining synthetic foams and structural



{ The aluminum-block 5.7L V8 produces 345 horse

power. In the end, the balsa, while expensive, proved to deliver the greatest benefits. The damping properties of our floor are such that the vibrations are readily absorbed. With a typical steel floor, you'd have to add a great deal of sound-deadening material to isolate the passenger compartment. And thus, add unneeded weight.



T h e N e x t



but the C5 Corvette, after all.}

# culty of simplicity.

Chief Engineer



rpm, thanks, in part, to its new intake port design. }

et the structure right first. The frame rail of the Corvette chassis is a single, uninterrupted hydroformed piece of steel running 15 feet from the front to the back of the car. We looked at a typical 4-piece frame rail assembly and decided there had to be a better method to engineer the part. What we designed is completely unique. It's the

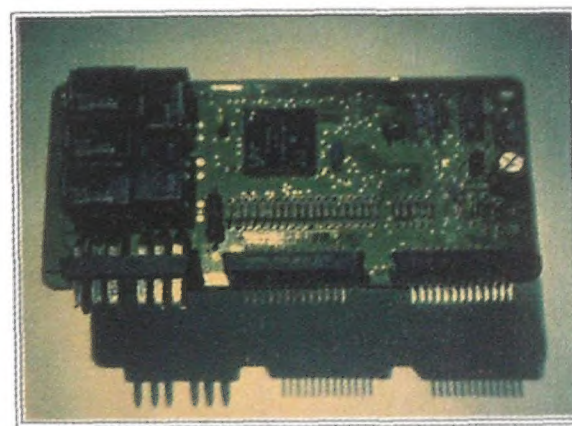
biggest hydroformed piece in the world. The precision of its circumference is within a millimeter for its whole length. The hydroformed piece is less likely to deteriorate than a welded-up frame rail. That means it's less likely to get weaker over time and begin to have parts flex or creak or squeak or rattle. All because we began with a simpler approach.

The inherent stiffness—and goodness—of the structure allowed us to design a suspension that's easier to drive quickly than Corvettes of the past.

Making one part do the work of many. Many of the electronics in the C5 Corvette are controlled through multiplexing, where commands are sent through the wiring to controllers and actuators. Instead of sending information in parallel, we're able to do it serially. So, fundamentally, we can use a lot less wiring in the car. That simplifies

assembly. And second, it gives the driver additional benefits at no additional cost: Things like programmable door locks. Driver and passenger express windows. Seat position memory.

We've even gone to a drive-by-wire system for the throttle. Electronic throttle control gives you a



{ Advanced electronic multiplexing simplifies assembly and offers added driver convenience. }

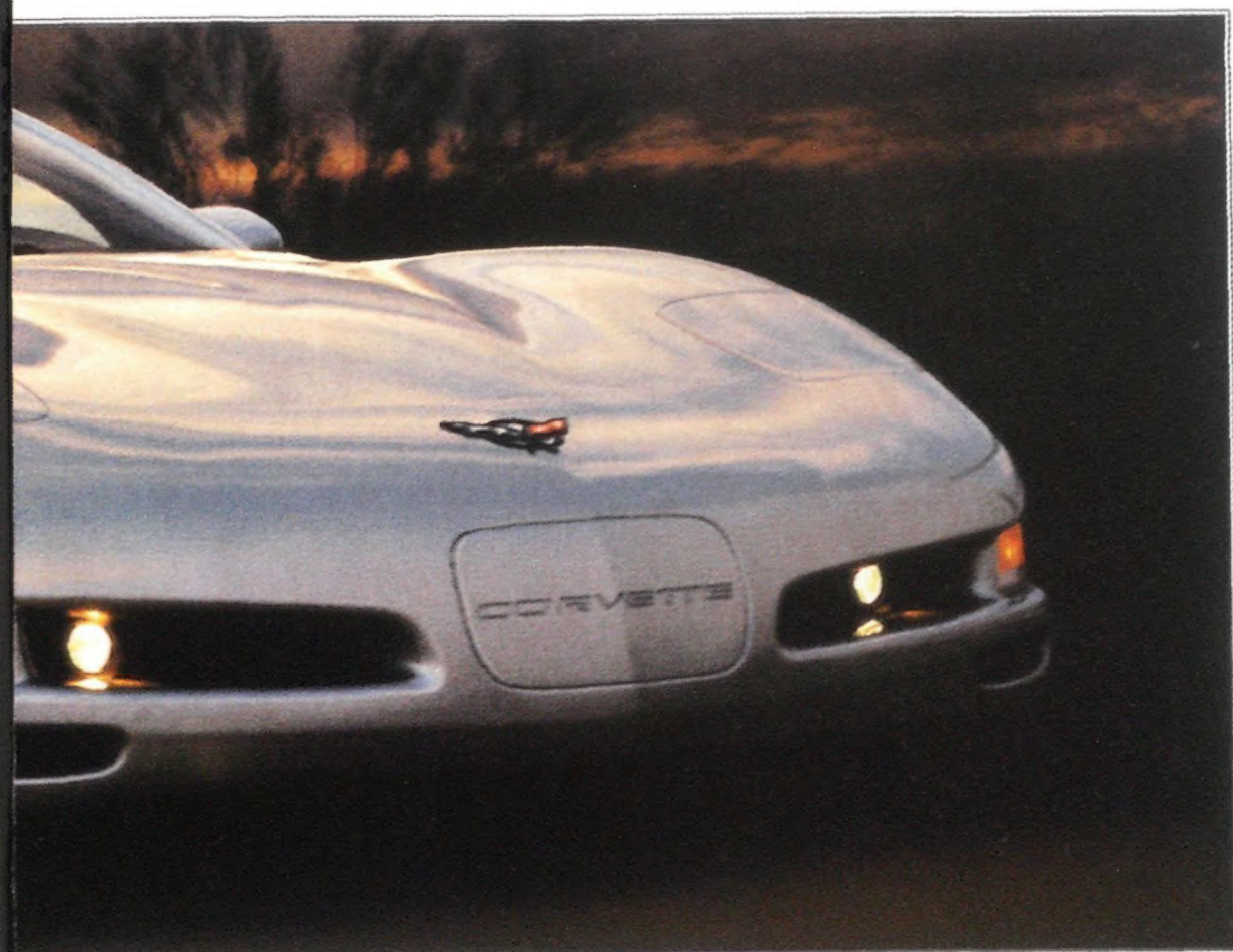
pedal which is very well isolated. And a much nicer traction control system. You just put your foot down. The electronic throttle control opens the engine throttle as much as it can to accelerate the car as fast as the tires will allow.

The next Corvette. The Corvette is very user-friendly. We've developed the car with a great deal of care and passion. It's a design that looks great and works greater. You can see it for yourself on the showroom floor.



Call 1-888-NEW-VETTE  
or visit [www.chevrolet.com](http://www.chevrolet.com)

\*Mileage shown with optional manual transmission. Corvette is a registered trademark and the Corvette Emblem is a trademark of the GM Corp. ©1997 GM Corp. Buckle up, America! ®



C o r v e t t e



# AIR & SPACE

Smithsonian

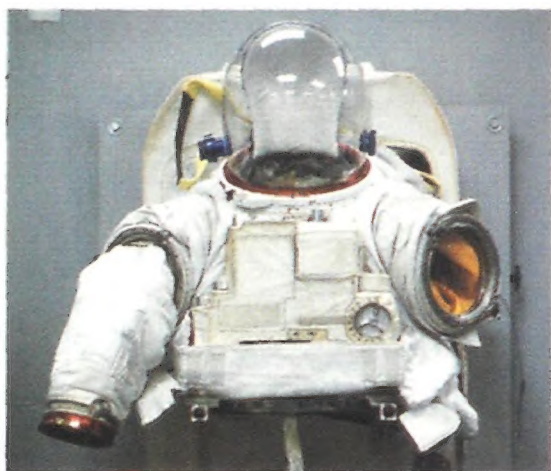


32



VIETNAM  
MEMOIR

- 62 Fifth in a Series**  
**Change of Command**  
by Ralph F. Wetterhahn  
*The pilots of the 8th Tactical Fighter Wing sensed they'd gained a good commander in Colonel Robin Olds. Nine minutes in the air near Hanoi convinced them.*



40

## CONTENTS

- 22 The Reconstruction**  
by William Triplett  
*Illustrations by David Povilaitis*  
*In this somber puzzle, the completed picture is an airplane and—ideally—an answer.*
- 32 Summer Hours** by Patricia Trenner  
*Photographs by Caroline Sheen*  
*Where are tomorrow's airline captains? Fattening their logbooks flying planeloads of tourists over the beach.*
- 40 Spacesuit Saga: A Story in Many Parts** by Frank Kuznik  
*Photographs by Breton Littlehales and by David Nance*  
*Chic, no. But these garments are still the height of sophistication.*
- 50 X-1: An Inside Look** Captions by Barry DiGregorio  
*Photographs from the collection of Carolyn Moore Baumet*  
*It's been 50 years since the X-1 made history. In these rare photographs, engineer Wendell Moore documented the secret project before the sonic boom heard 'round the world.*
- 56 X Marks the Spot** by the editors of *Air & Space/Smithsonian*  
*Site of the X-1's triumph, Edwards Air Force Base is a legend in the world of flight testing. An aerial tour shows why.*
- 70 The Making of Air Force One** by George C. Larson  
*This film's stars are among the biggest in the business—particularly the one weighing half a million pounds.*
- 76 Reflections on the Cold War: Seventh in a Series**  
**Stakeout** by William E. Burrows  
*As the Soviets' accomplishments in space grew during the cold war, so too did the need for spies.*



22



AIR & SPACE



**Cover:**  
*The photograph is by Houston-based Pam Francis; the spacesuit's jaunty pose is by assistant Laura Ragsdale, fastened inside.*

## Departments

- |    |                          |    |                    |
|----|--------------------------|----|--------------------|
| 4  | Viewport                 | 86 | Sightings          |
| 6  | Letters                  | 88 | Reviews & Previews |
| 10 | Soundings                | 92 | Calendar           |
| 16 | In the Museum            | 94 | Credits            |
| 18 | Above & Beyond           | 95 | On the Web Site    |
| 20 | Flights & Fancy          | 95 | Forecast           |
| 75 | The Smithsonian Traveler | 96 | Collections        |

*AIR & SPACE/Smithsonian* (ISSN 0886-2257) is published bimonthly by the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560. ©Smithsonian Institution, 1997. All rights reserved. Reproduction in whole or in part without permission is prohibited. Editorial offices: 901 D Street SW, 10th Floor, Washington, DC 20024. Advertising and circulation offices: 420 Lexington Ave.,

New York, NY 10170. SUBSCRIPTION PRICES: U.S. and possessions: \$20 a year payable in U.S. funds. Canada and all other countries: add \$6.00 (U.S. funds) per year. Eighty-five percent of dues is designated for magazine subscription. Current issue price: \$3.95 (U.S. funds). Back issue price: \$5.00 (U.S. funds). Periodical postage paid at Washington, D.C., and additional mailing of-

fices. MAILING LISTS: We sometimes make our subscriber list available to companies that sell goods and services by mail that we believe would interest our readers. If you do not want to receive such mailings, send your current mailing label or exact copy to: *AIR & SPACE/Smithsonian*, Mail Preference Service, PO Box 420113, Palm Coast, FL 32142-0113. ADDRESS CHANGES AND SUB-

SCRIPTION ORDERS: Mail to *AIR & SPACE/Smithsonian*, PO Box 420113, Palm Coast, FL 32142-0113; call 1-800-766-2149; visit Web site <http://www.smithsonianmag.si.edu>; or go to the Smithsonian Online area of America Online (keyword: Smithsonian Magazine). Postmaster: Send change of address to *AIR & SPACE/Smithsonian*, PO Box 420111, Palm Coast, FL 32142-0111.





You don't slap a Special Edition Gee Bee Stamp on a letter, you stick it in a hangar (a picture frame would be nice). Or you could set

**FLY IT ANYWHERE YOU LIKE.  
JUST DON'T LAND IT ON AN ENVELOPE.**

this baby down in a stamp album. Either way, it'll live to fly another day.

Classic American Aircraft Stamps are a formation of twenty great stamps. Each one is a tiny work of art, soaring with color and detail.

To see the Gee Bee and other Special Edition Stamps, call 1 800 STAMP-24. And there's always the post office, if you feel like dropping by.

**Some Stamps You Just Can't Lick,**



*Mini Print Collection  
Set of 5 \$19.95*





Secretary of the Smithsonian Institution  
I. Michael Heyman

Editor  
George C. Larson

Executive Editor  
Linda Musser Shiner

Senior Editor  
Patricia Trenner

Senior Associate Editor  
Perry Turner

Associate Editors  
Karen Jensen  
John Sotham  
Diane Tedeschi

Photography/Illustration  
Caroline Sheen

Design Direction  
Phil Jordan  
Gretchen L. Maxwell

Cover Design  
Lasko Design

Publisher  
Ronald C. Walker

Administration  
Carey O. Randall, Associate Publisher

Advertising  
Louis C. Kolenda, Director

Circulation  
Liberta Abbondante, Director  
Caroline Topak, Marketing Director  
Elizabeth Hopkins, Planning Director  
Andrea Sole, Fulfillment Director

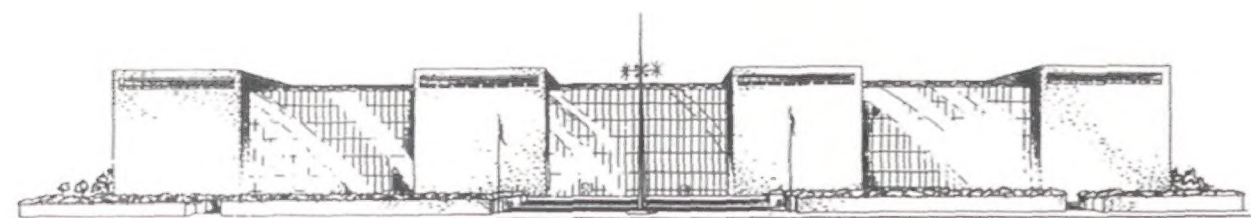
Production  
Sarah D. Kingsley, Manager  
Sue Nixon, Editorial Production  
Specialist

Business  
Shelia Perry Brannum, Manager

Founder  
Walter J. Boyne

Publisher Emeritus  
Joseph J. Bonsignore

Telephone  
Editorial: (202) 287-3733  
Advertising: (415) 454-9782



## Footsteps in the Sand

**T**he National Air and Space Museum often hosts events for super-achievers in the aerospace field. These people have performed some amazing feats of skill and determination, so these occasions are always fun.

At one such event last May, I was moving through the crowds at the Milestones of Flight Gallery when I ran across someone familiar. I could not place him at first, and then he reminded me that we had met about 10 years ago, when I had visited Taos, New Mexico, where he was the airport manager.

I had flown to Taos in N1, the FAA's aging Lockheed JetStar four-engine business jet. As the administrator of the Federal Aviation Administration, I had been invited by Garrey Caruthers, then governor of New Mexico and also a pilot, and the state's U.S. senator, Pete Domenici, to attend a town meeting on the need to improve Taos Municipal Airport. The airport was located outside the town at 7,091 feet above sea level and perilously near the edge of the grand gorge of the upper Rio Grande River. High altitudes and natural hazards demand respect from any pilot, so I took the prudent course and landed uphill and away from the gorge on Runway 04, a 5,800-foot strip—and I used every bit of it: I finally came to a full stop with the nose of the airplane hanging over the end of the runway.

As I turned around and headed for the terminal, I made a mental note to take off in the opposite direction on Runway 22 when I departed later. This would take me away from the rising terrain, and if necessary, I could convert the 500-foot vertical drop into the gorge at the west end of the field to some useful purpose.

I taxied up to the terminal building, which was smaller than the JetStar, and was met by the airport manager and his friends. I noted the airport weather observation station just outside the door of the terminal: Three sturdy sticks were tied together like a teepee, and from the top hung a piece of old rope with a flat stone at the end. Printed on a weathered board propped against one of the legs

were these instructions for weather observation: "The rock will blow in the wind to indicate direction and force. If the rock is wet, it is raining. If the rock is white, it is snowing." It seemed pretty straightforward.

We proceeded into Taos, where the governor, the senator, the mayor, and I sat on the dais while the mayor conducted a meeting. Many of the town's residents were in the audience. The pilots spoke of the need for the FAA's help to improve Taos Municipal Airport. My landing had convinced me that it needed help, and I had already decided to commit the necessary dollars. After listening to the reasoning and rationale of the pilots and the airport's supporters, the mayor then called on an elderly war chief from the Taos Pueblo.

The chief used lilting words, almost like poetry, and while he spoke of the need to upgrade the airport, he also reminded us of something more significant. In his spellbinding manner he drew our attention to the temporary nature of man's footsteps in the sands of time and how they are erased by the wind and by the greater force of nature. He said that man should try to build just what was necessary while respecting what God had given us.

On departure, a propitious wind enabled me to use Runway 22, with the gorge option available if needed. The JetStar used all of the runway and even blew some of the dirt from the overrun, but once we cleared the end and dropped over the cliff we were able to gain airspeed and climb away.

Now, 10 years later in a crowded reception at the National Air and Space Museum, I asked the airport manager if the taxiway had been installed.

"No, not yet," he replied.

I wondered to myself, *Maybe the old war chief had a direct line to higher authority.* And maybe that taxiway was not meant to be.

—Don Engen is director of the National Air and Space Museum.



# "We've never seen a better credit card!"



Ben Franklin  
A penny saved is a penny earned. But now a penny spent can earn you free U.S. Savings Bonds.

By the way,  
what's a credit card?"



Thomas Edison  
Practically the only thing he didn't invent was plastic.

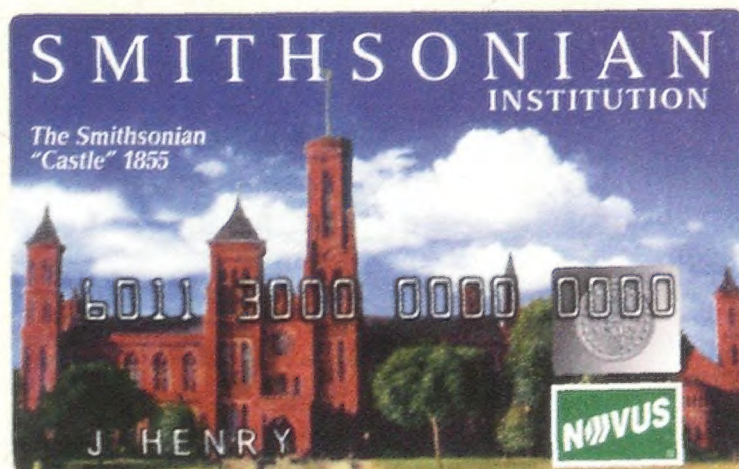


Harriet Tubman  
She used the Underground Railroad to plan great escapes. But all you need is this card.

It's Ben Franklin's credit card. And Harriet Tubman's. In fact, it's the credit card of just about any historic American you can name. It's the Smithsonian Card.

*Save For Your Future, and Support The Smithsonian.*

Every time you make a purchase you'll help the Institution preserve America's past. And you save for your future too, because you'll earn points toward free U.S. Savings Bonds\*. So apply today. There's never been anything like this before in the history of America.



To apply, call toll-free  
1★888★33CASTLE

USE WHERE  
YOU SEE





*Secretary of the Smithsonian Institution*  
I. Michael Heyman

*Director, National Air and Space Museum*  
Vice Admiral Donald D. Engen,  
U.S. Navy (ret.)

*Board of Regents, Smithsonian Institution*

*Ex Officio*

Chief Justice of the United States  
William H. Rehnquist, Chancellor  
Vice President of the United States  
Albert Gore Jr.

*Appointed by the President  
of the Senate*

Honorable Thad Cochran  
Honorable Bill Frist  
Honorable Daniel P. Moynihan

*Appointed by the Speaker of the House*

Honorable Sam Johnson  
Honorable Bob Livingston  
Honorable Esteban E. Torres

*Appointed by Joint Resolution of Congress*

Honorable Howard H. Baker Jr.  
Honorable Barber B. Conable Jr.  
Mr. Louis V. Gerstner Jr.  
Dr. Hanna H. Gray  
Ms. Anne d'Harnoncourt  
Dr. Manuel L. Ibáñez  
Dr. Homer A. Neal  
Mr. Frank A. Shrontz  
Mr. Wesley S. Williams Jr.

*Contributing Editors,  
Air & Space/Smithsonian*

Michael Beschloss	Frank Kuznik
Roger Bilstein	W. David Lewis
William E. Burrows	Stephen Maran
Eric Chaisson	Laurence Marschall
Tom Crouch	Ted Maxwell
David DeVorkin	Ron Miller
Ron Dick	James Oberg
Freeman Dyson	Edwards Park
Daniel Ford	Dominick Pisano
Greg Freiherr	Robert E. Pollack
Owen Gingerich	Fred Reed
Donald Goldsmith	Tony Reichhardt
Stephen Jay Gould	George Robinson
George Greenstein	Theodore Robinson
William Gregory	Chad Slattery
R. Cargill Hall	Marcia Smith
Richard Hallion	Robert W. Smith
Jim Hansen	Jill Tarter
Gregg Herken	Steven L. Thompson
Nick Komons	Albert Van Helden
Nick Kotz	G.L. Verschuur
Saunders B. Kramer	Stephan Wilkinson

### Who You Calling Ugly?

I think the P-61 Black Widow is elegant. If you had to include a World War II plane in "Plug-Ugly" (June/July 1997), what about the asymmetrical Blohm und Voss 141, the Junkers 87 Stuka, or the Messerschmitt 323? If you had to have an American aircraft, the Consolidated B-24 is way uglier than the P-61.

—Thomas T. Kipp  
Columbus, Ohio

How could you list the P-61 as one of the ugliest aircraft ever built? The Black Widow simply looks like what it is: a big, nasty bully that will beat you senseless.

And what right does a Royal Air Force officer have to criticize an American airplane? After all, Ron Dick is a native of the nation that produced the Fairey Gannet.

—Wade Petrilak  
Warminster, Pennsylvania

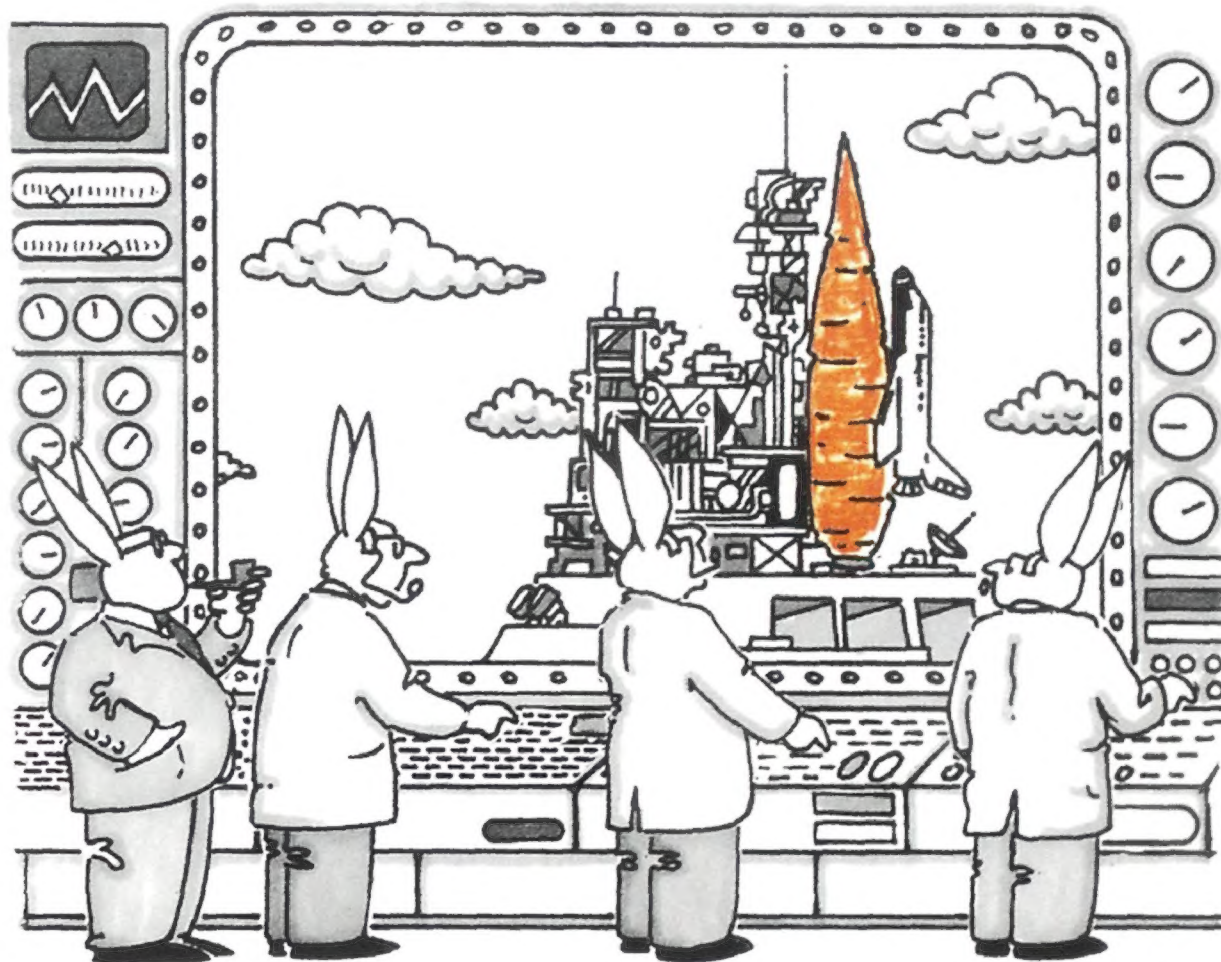
In my opinion, the most stomach-turning, obscenely ugly airplane ever is the Fairey Gannet. It has too many tail surfaces, too many bulges on too fat a body, and too many propellers for a single engine. And the air intake looks like the smile of a demented clown.

As for the least appealing jet aircraft, I nominate the English Electric Lightning, with its over-and-under engine arrangement, missile pylons on the top of the wings, and flying surfaces that look like they were designed with an industrial-strength paper cutter.

—Al LaFleche  
via e-mail

Why did Ron Dick overlook his own country's snub-nosed Bristol Beaufighter Mk. I or thimble-nosed Mk. X? As far as aesthetics go, I'll take the P-61 over the Beaufighter any time.

—James E. Masterson  
Natick, Massachusetts



**HARDIN**



I guess Ron Dick never saw a Lancaster—now *that's* ugly.

—Lt. Col. Paul F. Harrington  
U.S. Air Force (ret.)  
Seminole, Florida

My candidate, the A-31/A-35 Vulture Vengeance, looked like it might have been designed by a fifth grader using nothing but straightedges. It made the P-61 look good.

—David H. Rust  
Woodville, Texas

How could you not include the Transavia Skyfarmer? It looks like a flying midair collision.

—Rick Boyette  
Royal Palm Beach, Florida

As builders of an aircraft that will be in demand throughout the world at least halfway through the next century, we see the Loadmaster's pursed-lip look not as the expression of a sigmoidoscopy patient but rather as a radiant smile.

—Tex Guthrie  
Director, International Sales, Ayres Corporation  
Phoenix, Arizona

If these are the ugliest planes you could find, that sure raises doubts about your collective ability and intelligence. Of course, you may be doing this as a stunt just to see if anyone is paying attention. But I doubt it. I think you really are that dumb.

I see nothing ugly about the Skyvan, the Heyford, the F-91, or the Loadmaster. And I know there are dozens of planes just as ugly as the Jabiru and the Bulldog because I have a book of them in the cellar.

If you have nothing better to do than print this kind of drivel, then you really need a job or hobby to keep you busy.

Shape up.

—Walter P. Niemiec  
Easthampton, Massachusetts

I just got my June/July issue at work and was thumbing through it on the way to the Coke machine. The comments on the plug-ugly airplanes got me laughing so hard that I had to stop in the hall and lean on the wall. If I hadn't put the magazine away, I wouldn't have gotten any more work done. A tip of the wing to the writers of this goofiness.

—Pete Harrell  
via e-mail

### Can't Keep a Good Mohawk Down

Mohawk enthusiasts may take some joy from the fact that OV-1s are still serving on active duty ("The Last of the Mohawks," Feb./Mar. 1997). At least 23 were supplied to the Argentine army, which continues to operate most of them.

—Dan Hagedorn  
Archives Reference Team Leader  
National Air and Space Museum  
Washington, D.C.

*Editors' note: For more information, contact the OV-1 Mohawk Association at 1360 Keenan Way, San Jose, CA 95125; phone (888) 7 MOHAWK; via Internet at [www.ov-1mohawk.org](http://www.ov-1mohawk.org).*

### A Hole in the Story

In "Some Assembly Required" (June/July 1997) Henry Cooper gave readers the impression that during extravehicular activities, Russians get into more problems than Americans

# F-18 JET OPTIONAL



## BLACK STEEL FIGHTER COMMAND CHRONOGRAPH DESIGNED FOR MILITARY PILOTS

The best watches in the world are made in Switzerland.  
The best watches in Switzerland are made in Geneva.  
**CHASE-DURER'S Fighter Command is made in Geneva.**

Precision SWISS ETA 251.265 Movement / 6 Hands  
4 Push-buttons / 4 Dials / 1/100th Sec Timing • Dual Time Zones  
Speed Tachymetre / Digital Alarm / Hardened Mineral Crystal  
Lens / Twin Digital Readouts / Solid Stainless Steel Case &  
Band / Tritium Hands & Indexes / W/R to 330 ft / Revolving 360°  
Heading Marker Bezel / 12 Hour Elapsed Time / Calendar Day &  
Date Windows / Serial No. / 30 Day Money Back Guarantee  
2 Year Buckle to Buckle Warranty

**\$700 Value - NOW ONLY \$449 + \$6 S&H**  
**Credit card customers may pay in three (3) interest  
free monthly installments of \$150 each**

Or send check or Money Order to: **CHASE-DURER**  
270 No. Canon Dr, Dept 1402-326 • Beverly Hills, CA 90210  
Ph 310-550-7280 / Fax 310-550-0830

**CREDIT CARDS CALL: 1-800-544-4365**  
**ASK FOR OPERATOR 326**



because they rehearse less, and he illustrated this by recounting that during a 1991 spacewalk on Mir, Anatoly Artsebarsky's face plate fogged up. I am a good friend of Anatoly's, and he told me the real story.

While the rules for EVAs require a new set of gloves be worn on every EVA, on that mission the stock of custom-fit gloves was running low. As a test, Anatoly was given permission to perform a second EVA with a previously worn pair of gloves. It was toward the end of that EVA that a metal burr on one of the trusses he was assembling made a small hole in the index finger of his right glove. This in turn caused a slow depressurization of his spacesuit. It was frost, not fog, that ended up obscuring his face plate.

—John H. Scharres  
Woodstock, Illinois

### Saved From the Scrap Pile

In George Larson's review of *Back to the Drawing Board* (Apr./May 1997), he states that the World War II Brewster SB2A Buccaneer/Bermuda bomber "was replicated 1,052 times...and went straight to scrap." I take exception to that. We flew SB2As during operational training at Naval Air Station Vero Beach, Florida.

—Lt. Col. D.S. Hopkins  
U.S. Marine Corps (ret.)  
Green Valley, Arizona

*Editors' reply: It would have been more accurate to quote Back to the Drawing Board directly, in which Bill Gunston writes: "Not one got into front-line use, and the vast majority were simply scrapped...." According to United States Navy Aircraft Since 1911 by Gordon Swanborough and Peter M. Bowers, the Dutch had ordered 162 SB2As, and when the Netherlands was overrun, these aircraft ended up being used by U.S. Marine squadrons as trainers.*

### The Doomed Lives of Slick Six

"The Nine Lives of Slick Six" (Feb./Mar. 1997) reminded me of my experience on a project to build a fiber optic link around Vandenberg Air Force Base in 1989 and 1990. While trenching and digging, we were required to be accompanied by an environmentalist, an archeologist, a geologist, and other assorted inspectors, including a group of Chumash Indians, who lived nearby. Numerous Indian artifacts and burial grounds had been located and identified around the base by the Vandenberg archeology office, and the Chumash stood by to stop the work

in the event that we located any such materials or sites. During the project, the Chumash told me that they had tried to stop the Air Force from building on the site back in 1966 but had been unsuccessful. When crews began construction, they unearthed a sacred Indian burial ground. After 30 years of launch failures, I can't help wondering: Does a Chumash curse hang over the site?

—George Kniss  
Moon Township, Pennsylvania

### Wing Failure

I am a retired B-2 engineer. When I read "The Edwards Diaries" (June/July 1997), I became angry. Daniel Ford writes that the crash of the YB-49 killed the flying wing. This is totally wrong. Politics and greed killed the program.

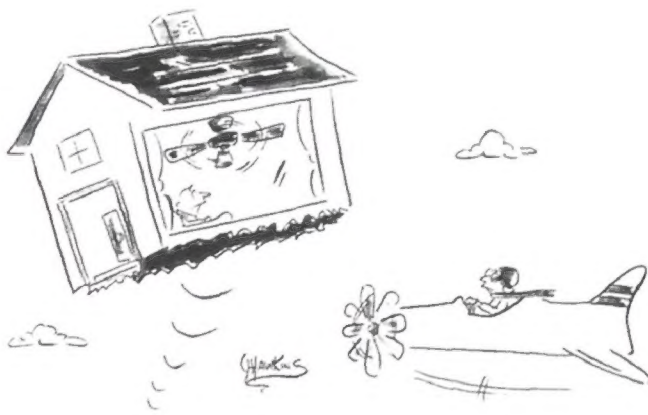
To make a very long story short: Floyd Odlum, chairman of the Atlas Corporation, and his good friend, Stuart Symington, Secretary of the Air Force, felt that there were too many aircraft companies. Odlum was collecting them—to name some, Consolidated and Vultee, which eventually were merged into Convair. Even though they were already working on the design of the B-36 bomber, Odlum and Symington came up with an additional plan: Build the B-35 in Texas and make Northrop a division of Convair.

At a meeting on July 16, 1948, Symington told Jack Northrop that he wanted Northrop Aircraft to combine with Consolidated. Northrop was stunned, and eventually he said no. That's when Symington ordered the B-35/B-49 programs canceled.

I had been working at Northrop for almost a year when the program was canceled. When we learned that all aircraft from the program were to be cut up for scrap, I smelled something rotten. Even the Smithsonian wasn't permitted to have one of the wings.

After watching the "Wings" program on the Discovery Channel and reading Ted Coleman's book *Jack Northrop and the Flying Wing*, I finally learned the truth.

—T.O. Pratt  
Pahrump, Nevada



*Daniel Ford replies: I too read Coleman's book (indeed, I reviewed it for the Dec. 1988/Jan. 1989 issue of this magazine) and watched the "Wings" installment with the Jack Northrop interview, but I found other sources more convincing: General Robert Cardenas' judgment that the YB-49 wasn't "an operational bird," the B-35/B-49 case histories from Wright Field, and the thesis Death of the Flying Wing (the author, Francis Baker, was an Air Force officer who set out to prove the conspiracy theory but ended up concluding there was nothing to it.) Long after Symington's supposed decree, the Air Force still tried to get a payback on its huge investment in the Wing. YB-35Bs were under conversion as late as October 1949. The YRB-49A didn't fly until 1950 and survived well into the Eisenhower years, so if the Smithsonian had wanted to rescue the Wing, it could have done so without repercussion.*

*Truly, the crash in the Mojave Desert killed the Flying Wing. The accident showed that the B-49 wasn't ready for prime time, nor could it have been made ready with then-existing technology.*

Anyone wanting to see some brief footage of the Flying Wing need only go to a video store and rent the George Pal classic *The War of the Worlds*. (The screenwriters were apparently unaware that the YB-49's bomb bay would have been too small to hold a "plutonium bomb.")

—Stephen Hashioka  
Chicago, Illinois

### Corrections

June/July 1997 "Plug-Ugly": The Siemens-Schuckert Bulldog pictured had an inline engine, not a rotary engine.

Photo box, p. 11, Soundings: Hale-Bopp's dust and ion tails both point away from the sun.

Apr./May 1997 "Thin Air, High Hopes": Steve Fossett's early 1996 attempt at a round-the-world balloon flight ended in New Brunswick, Canada, not Nova Scotia.

*Write to us at: Letters, Air & Space/Smithsonian, 901 D St. SW, 10th Floor, Washington, DC 20024. Please type or print clearly. You must include your full address and daytime phone number. Letters will be edited for publication.*

*Air & Space is not responsible for the return of unsolicited photographs or other materials. We regret that we cannot answer every letter personally.*

**e-mail** You must include your full name, mailing address, and daytime phone number. America Online: airspacedt, Compuserve: airandspace, Internet: editors@airspacemag.com.



**EXCLUSIVE OFFER TO AIR&SPACE READERS**

# CELEBRATING 50 YEARS of the U.S. Air Force



**FOR AIR&SPACE  
READERS ONLY!  
SLIP CASE EMBOSSED  
WITH LOGO ON  
FIRST 500 ORDERS—  
ORDER TODAY!**

**I**n honor of the 50th anniversary of the U.S. Air Force, AIR & SPACE/SMITHSONIAN has reserved 500 copies of this luxurious commemorative edition, SABRES TO STEALTH, published by the Royal Air Force Benevolent Fund. Only this limited run will feature the AIR & SPACE/SMITHSONIAN logo on the protective slipcase that comes with this extraordinary book. Orders will be fulfilled on a strict

first come, first served basis until supplies are exhausted.

This specially compiled hardback narrates the complete history of the U.S. Air Force as it could only be told by the R.A.F. In SABRES TO STEALTH you'll find all the events, people, and aircraft that have played the most important roles

as the U.S. Air Force evolved each year from its beginnings in 1947. Included are 50 fine color prints by leading aviation artists along with 150 high-quality photographs, all in 168 pages of rich, matte-finish paper. You'll want to own the story of the U.S.A.F. from the unique perspective of America's closest ally!

Please complete the form below and send in with your payment:

MAIL ORDER TO: Air & Space/Smithsonian, 901 D Street, SW, 10th Floor, Item #B9750, Washington, DC 20024.

FOR FASTEST SERVICE, phone 1-800-824-5974 toll-free to leave a recorded message with credit card information. You can fax credit card information to: 202-287-3163.

PLEASE SEND ME:

\_\_\_\_\_ copies of SABRES TO STEALTH each @ \$49.95 plus \$5 shipping via UPS and handling

☐ Check or money order enclosed

Make check payable to: Air & Space/Smithsonian

☐ Discover

☐ Mastercard

☐ American Express

☐ VISA

Acct. # \_\_\_\_\_ Exp. Date \_\_\_\_\_

Signature \_\_\_\_\_

MAILING ADDRESS:

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_





## Commerce Blooms in Paris

**D**ubai, Singapore, Johannesburg, Santiago—airshows are hosted at these and other far-flung destinations, but none can compare in size and influence to the biennial spectacle at Paris. “It’s the biggest toy store in the world for men and their toys,” says Sally Bath, director of the U.S. Department of Commerce Office of Aerospace.

The store is open for just nine days at Le Bourget airport every other June, but in that time it attracts some 132,000 customers—buyers for the airlines, airports, and air forces of 144 countries. This year over 1,800 exhibitors were on hand to sell to them, but the job for Bath and her staff is to support just the 400-plus companies based in the United States.

Scan the list of vendors and you’ll get a sense of the diversity of the aerospace industry. There were titans like Boeing and Lockheed Martin as well as the likes of Pacific Oil Cooler Service and

Billingsley Magnetics. The large airframe and engine manufacturers don’t need help from the government—they have elaborate displays built and run by their own specialists. “We serve as the corporate trade-event team for the small companies that want to be known in the international arena but don’t have the resources to prepare for a show on their own,” Bath explains. This year, for the first time, the U.S. booths were built and supplied by a private consortium under contract to the commerce department. Aerospace office staff members were on hand to help set up sales meetings and funnel in prospective customers.

Why is the U.S. government involved? “Because other governments are, pure and simple,” Bath says. Facing many foreign competitors that are government owned or subsidized, the rationale goes, the U.S. industry should receive some support to help it maintain its dominant

market position and the contribution it makes to the national balance of trade. In addition, the aerospace office helps show the flag at other major airshows and also provides such services as business counseling and assistance in trade agreement negotiations.

The office’s airshow support comes at no expense to the taxpayer. Exhibitor fees cover the costs. Fully outfitted, a 90-square-foot display in the Paris show’s USA National Pavilion rents for about \$9,500—about twice what the same amount of raw space goes for. Even without sending a representative, a company can have its catalogues and brochures distributed at the pavilion’s literature center for \$500.

Companies feel the effort and expense are worth it even though there are relatively few orders placed at trade shows. Like a couple courting, seller and buyer use the time to get to know each

other. Sales may take years to consummate. The happy couple then may use another airshow to make their announcement to the aerospace world. At Paris this year, for example, Finnair announced a commitment to purchase a mix of 12 Airbus 320 transports, a sale valued at up to \$700 million.

Because of the airshow, Le Bourget goes through a two-year cycle of boom and bust. “It’s almost like Woodstock,” says Tony Largay, an aerospace office staff member and director of the USA National Pavilion. “Beforehand, for 10 days, there’s frantic activity, building this thing from nothing into a finished, polished site. Then, three days after the show closes, it’s a ghost town again.”

—Lester A. Reingold

CHRIS SORESENSEN







SWISSAIR

was a time when that meant something. Airships have been alighting at the sprawling Navy base for most of the century, and during World War II the place was bubbling with Navy blimps on convoy escort patrols. But for all the airships that have come and gone, it was the *Hindenburg* fireball that put Lakehurst on the map. The 1937 *Hindenburg* disaster continues to hold a special fascination (see "Odorless, Colorless, Blameless," Apr./May 1997), partly because it was so

## Swiss Timing

The premise sounded something like a circle in Dante's *Inferno* dedicated to punishing evil New York City transportation executives: Take a crowded bus to Kennedy International Airport during rush hour for a flight to La Guardia—with a stop at Newark International—followed by a rush-hour return bus back to Manhattan.

In reality it was one facet of Swissair's commemoration of the 50th anniversary of its first flight from Geneva to La Guardia. As in that 1947 flight, the airliner was a DC-4, though this time the passengers consisted mainly of Swissair executives. Fifty years ago the crossing took 25 hours—and stormy weather forced it to divert to Washington. Last May, Swissair flew the DC-4 across the Atlantic and threw several parties upon arrival. For this joyride, the airliner wouldn't lose sight of *der Grosse Apfel*.

Now, as then, getting there was half the fun. During one particularly slow stretch of traffic on the way to JFK the airline execs began to grumble, and one rose to lecture the driver about his choice of route. "Relax—it's not like the flight's going to take off without us," someone muttered. Finally, the expedition rounded the last corner and the DC-4 came into view. Appreciative cooing rose from the passengers. The airplane, chartered from South African Airways and temporarily christened *Spirit of Swissair*, was decked in Swissair's circa-1947 livery. After much picture-taking and then boarding with the help of "stewardesses" in period garb (following screening by security personnel with non-period hand-held

metal detectors), the passengers strapped in. A lengthy wait followed while a crew member hand-pumped some hydraulic fluid somewhere, the four Pratt & Whitney radials roared to life.

While jumbo jets went about their business and the occasional ground crew stopped to gawk, the tiny *Spirit of Swissair* weaved its way to the runway. Once the flight crew firewalled the throttles, the DC-4 gradually built up speed, then nosed up and climbed to 1,000 feet. Below, Brooklyn slid by, and the Manhattan skyline hove into view. It was a warm May day and mildly bumpy, which separated the passengers into two groups: those who fought their way over the others to visit the flight deck, and those who gripped their armrests and stared glassy-eyed at the bulkheads.

Following a tour of Manhattan's skies and a stopover at Newark, the *Spirit of Swissair* touched down at La Guardia, completing a hat-trick tour of the East Coast's most odious airports. As the tires made contact the passengers burst into applause. The DC-4 came to a rest and a confused-looking ground crew struggled to mate a rolling staircase to its exit. "After fifty years we finally managed to land in La Guardia," Swissair's Jean-Pierre Alleman said. His audience, more aware of the current hazards of modern travel, quickly dissipated for fear of missing the chartered bus back to Manhattan.

—Phil Scott

## Lakehurst Pauses

The little central New Jersey town of Lakehurst prides itself on being the Airship Capital of the World, and there

## UPDATE

### In Memoriam

The aviation community suffered a great loss when writer, historian, and pilot Jeffrey L. Ethell died in the crash of a P-38 Lightning near Tillamook airport in Oregon on June 6. He was 49.

Taught by his father, an Air Force fighter pilot, Ethell learned to fly before he learned to drive. In the late 1960s he was awarded research grants from the National Air and Space Museum that set the stage for a career as an aviation writer. He went on to write some 60 books and over 1,000 articles for magazines, including this one ("World War II's Flying Colors," Aug./Sept. 1991, "Wings of the Great War," Oct./Nov. 1991, "At the Threshold of Space," Oct./Nov. 1993), but he always maintained that "writing is the punishment for getting to fly."

Ethell, who had an "Unrestricted" authorization from the Federal Aviation Administration to fly World War II fighters, had logged some 5,000 hours in 215 aircraft types, from the Fokker D.VII to the McDonnell Douglas F-4 Phantom II. He was an honorary member of the American Fighter Aces Association and the Order of the Daedalians.

Ethell's father had flown P-38s and his son grew up enamored of the fighter. "Before I was a teenager, I knew the P-38 was the airplane I wanted to fly more than any other," he wrote in an article published just days before his death.



# Ditch the Joneses.



Although there's something to be said for getting ahead, the new Navigator has more to do with getting away. And taking life's luxuries with you. With up to 8000 pounds of towing capacity. Available Control-Trac 4WD with load-leveling suspension that lowers the vehicle for easier entry.

 **LINCOLN**





And a 5.4L V8 for those who wish Joneses and all (nothing against anyone named Jones). For information about this full-size luxury utility vehicle, call toll-free 1-800-255-2529 or visit our web site at [www.lincolndrive.com](http://www.lincolndrive.com) or see an authorized Lincoln Navigator dealer.

**Navigator from Lincoln. What a luxury [  ] should be.**



graphically and grippingly documented, partly because the victim was so gigantic. One demonstration of the doomed ship's legacy is a memorial service conducted at dusk every May 6 at the very spot it fell.

I had thought the event would draw some locals and maybe a few history buffs, so when I attended the service this year, I was unprepared to see row upon row of cars and pickups—some 200—parked a half-mile beyond old Hangar One. There were maybe 500 people gathered, from old men and women to teens and scouts and babes in arms. All were crowding around the ground marker and the little *Hindenburg* weathervane that commemorate the event.

At 7:25 p.m., the moment the ship burst into flames, an honor guard of Sea Cadets stepped forward with flags aflutter. Presently, the air station's chaplain asked all to pray for those who suffered that night and for those who came to their aid. Next, two grandsons of *Hindenburg* victim Allen Hagaman, a Navy man who was crushed by one of the ship's massive diesel engines, came forward carrying a flowered wreath. Finally, Carl Jablonski, head of the Navy Lakehurst Historical Society, read the names of all 36 who had died. After a final prayer, the brief ceremony ended. Within minutes everyone was gone.

Jablonski says the number of people attending the annual service has been increasing. He believes so many more attended this year because of better publicity, the fact that it was the 60th anniversary, and because "people are more interested in the history of their country, in what was and what was to be."

For Ed Kearns, the occasion was not about discovery but recollection. He'd been one of the teenagers hired at \$1 a day to handle the airship's lines. He was holding a bowline when the *Hindenburg*

exploded above him.

"I looked and practically the whole thing was in flames," he says. "And then I saw people jump, which was horrible. We were all running very fast. You know something big like that right over your head, you're not gonna stick around. And I remember a chief petty officer hollering, 'Stand fast! Stand fast, sailors!' when it was crashing to the ground."

Kearns says for many years discussions about the tragedy would upset him so much he would remove himself from the conversation. "Of course, time has passed," he says; "60 years. I'm 78 now and it doesn't bother me anymore." Not a bother, perhaps, but not to be forgotten either.

—William Garvey

### Friendship 76

As *Air & Space* went to press, administrative offices at the Johnson Space Center in Texas were abuzz with the news that the first American to orbit Earth, John Glenn, who turned 76 in July, might be offered a seat on an upcoming shuttle flight.

NASA officials in Washington said they had discussed the possibility with the ex-astronaut—now the Democratic senator from Ohio—and were "giving it further consideration."

Glenn was one of the original seven U.S. astronauts chosen in 1959. On February 20, 1962, he circled the planet three times before his Mercury capsule *Friendship 7* splashed down in the Atlantic Ocean near the Bahamas.

As a public official, Glenn has brokered discussions between NASA and the National Institute on Aging about possible research ventures. Now that the U.S.-led International Space Station seems destined for reality, NASA is becoming more interested in how biomedical research in space can add to similar studies on Earth, including those on the aging process. Experiments on astronauts

have shown that exposure to weightlessness causes bones to deteriorate as if they are afflicted with osteoporosis.

Glenn wasn't talking and his press office was playing down the rumor. "There's not a program in place to put a senior citizen in space," said spokesman Brian McCleary. "Would he like to be part of an aging-in-space study when it comes along? Sure. The senator has made no secret [of that] over the last 20 years."

If Glenn's previous attempts to launch his own return to space fizzled, a former aide who's now a White House insider finally may have lit the fuse. President Clinton's press secretary, Mike McCurry, endorsed a second spaceflight for his ex-boss. "I think it's a dandy idea," McCurry said. "I think he's vigorous. He has been a pioneer in many ways, and many of the space program issues that are now being examined have interesting implications for older populations."

The White House spokesman uttered the words on a Saturday. By the following Monday, two flight opportunities had been identified: either the shuttle's ninth and final planned trip to the Russian space station next May, or a science research excursion scheduled for October 1998.

If Glenn accepts a shuttle assignment, he will become the oldest human to fly in space and will break a record set last year by Story Musgrave at age 61.

Putting Glenn on the shuttle would violate a ban on putting non-agency personnel in space that NASA imposed after teacher-in-space Christa McAuliffe perished with six astronauts in the 1986 *Challenger* disaster. It would be difficult to explain to Barbara Morgan, the teacher who's been promised an opportunity to carry out McAuliffe's mission if the ban ever is lifted. It also would be difficult to explain to Musgrave, who had been told by NASA that he couldn't fly in space again because he's over 60. Musgrave is retiring from NASA at the end of August.

—Beth Dickey

WADE MOLNAU (6)



When a Delta II booster exploded 13 seconds after liftoff at the U.S. Air Force's Cape Canaveral launch facility last January 17, Wade Molnau had the presence of mind to document the explosion with his



35-mm camera. "I was in Florida for the Global Positioning System Partnership meeting," he writes. "The culminating event was to be the launch of the first GPS 2R satellite. We were at the official







NASA DRYDEN

"Accepting the Challenge of Flight," a new mural at NASA's Dryden Flight Research Center in California, celebrates the center's 50th anniversary. "Dryden director Kenneth J. Szalai wanted a work that reflected the center's significant past achievements, its current programs, and future goals, as well as including Dryden pilots, engineers, and designers," writes artist Robert McCall, who 20 years ago painted a mural at Dryden entitled "The Spirit of Aerospace Research." McCall used Dryden employees as models for what he calls the first tier of the painting. The second tier depicts aircraft that have flown at the center, and the third is the artist's vision of Dryden's future aircraft.

## Grissom Wins the Battle

Webster's New American Dictionary defines an astronaut as a traveler in a spacecraft.

In Betty Grissom's dictionary, an astronaut is a person trained to fly at high altitudes. "That's what it said in 1963," says the widow of Virgil "Gus" Grissom—America's second astronaut-according-to-Webster (via his suborbital Mercury flight aboard *Liberty Bell 7* in 1961). "To me, there are two people on a flight that are astronauts: the commander and the pilot. The others are passengers. They've got it down now to where 'astronaut' means

absolutely nothing."

Grissom set off a local media frenzy in east central Florida last May when she complained that the U.S. Astronaut Hall of Fame in Titusville was committing an injustice by refusing to induct Roger Chaffee, the rookie who perished with her husband and Edward White II when their Apollo 1 capsule caught fire on its launch pad in 1967.

"Roger deserves to be in the Hall of Fame," says Grissom. "You have to have exceptions to all the rules." She stormed out of a meeting of the Astronaut Scholarship Foundation when her fellow board members—including Alan Shepard

and the other four surviving members of the Mercury Seven—vetoed her demand. "We feel like it's a sound policy and we voted to keep it," the foundation's executive director, Howard Benedict, said at the time.

Grissom alerted the *Orlando Sentinel* newspaper, which, along with *Florida Today*, rallied behind her with disapproving editorials. Two weeks later, the foundation announced a unanimous decision: No longer must an astronaut venture beyond the atmosphere to be considered; now he or she merely must make "an important or significant contribution to the space program."

"Pioneers belong in the Hall of Fame, and in retrospect, we've decided Roger Chaffee is a pioneer," Benedict says now.

Chaffee will be inducted this October along with the rest of the Apollo astronauts who are not already memorialized as Mercury/Gemini veterans. "If he hadn't died in his spaceship, we never would have gone to the moon," says Benedict, recalling the nuts-and-bolts capsule redesign done in the aftermath of the fire. "There is a significant contribution he has made."

The tiff had its roots in Betty Grissom's belief that NASA, 30 years later, is still trying to sweep the accident under the rug. "The families of the whole Apollo 1 crew feel like we've been stepped on," she says. Two years ago, she led an aborted campaign to have the charred capsule put on permanent public display at the Hall of Fame. The board and the space agency decided her proposal was inappropriate.

If Betty Grissom alone were selecting astronauts to be enshrined in the Hall of Fame, there would be no place for the likes of the New Hampshire social studies teacher who died aboard *Challenger* in 1986. "I don't consider her an astronaut," says Grissom. "I'm going to have a hard time explaining that one, but it's still my feeling. I can't compare Christa McAuliffe to Roger Chaffee."

—Beth Dickey



viewing area about two miles from the launch, which was at 11:28 a.m. (the clock on my camera was off by 54 minutes)." The Delta exploded at 1,589 feet, raining 254 tons of debris and propellant



over the air station complex. The blast, which was heard 25 miles away, destroyed the first of a new generation of Lockheed Martin GPS spacecraft.





# My Father, Charles Lindbergh

**W**hen he was in kindergarten, one of my brothers told a friend that our father had discovered America," said Reeve Lindbergh Tripp, the youngest child of Charles and Anne Morrow Lindbergh. "About the same age I dreamed he was God. If our father was God, that explained everything: why we called him 'Father' when all our friends called their fathers 'Daddy.' Why so many people spoke about him with a kind of reverence. Why the house shook when he was in a bad mood. And why I could find him in the Encyclopedia Britannica."

Reeve, 52, was at the podium in the Museum's Langley Theater, reading to a rapt audience from a memoir in progress about growing up in a Connecticut household with four siblings and famous parents. She has inherited her father's looks, her mother's small frame, and both parents' gift for language. In her presentation, "Of Words and Wings," she spoke reverently of her mother, now 90 and still living in the Connecticut house, but she held us spellbound when she talked about flying with her father—particularly me, since my father and I flew from the same little airport as the Lindbergh clan, and my father sometimes saw her father saddling up an Aeronca.

"My sense of my father as a pilot came from flying with him on Saturday mornings," she said. "I spent many Saturdays flying with Charles Lindbergh, thousands of feet over Connecticut. I wish I had known that at the time."

Charles Lindbergh was a constant lecturer, particularly when it came to safety in airplanes. Reeve and her siblings had been taught at an early age the dangers of a whirling propeller. "We could

list almost as well as he did the various limbs that had been severed from the bodies of careless individuals in a split second," she said. "Every time Stanley would start the propeller, I'd peer through the blinding blur to see if I could catch a

glimpse of any pieces of him that might go flying through the air." (Stan Konecko owned the flight school/rental operation and was often called upon to start customers' engines by hand-propping them.)

Reeve was not smitten with flying: "I

ERIC LONG



*Reeve Lindbergh Tripp and her son Benjamin, the daughter and grandson of Charles A. Lindbergh, came to the Museum last May to see the Spirit of St. Louis. As a child, Reeve (opposite, with her father and brother Jon in 1953) would fly with her father on Saturday mornings over Connecticut.*



found it a little monotonous," she admitted. "My father did the same things, and he said the same things—loudly—over and over. I knew by heart that a pilot had to fly with a steady hand, no sudden or jerky movements, just a little throttle here, a little wing dip there, always a light, even touch. There was no room in my father's lessons for soaring like the birds. We just droned along, my father and me. And then, one Saturday afternoon, we didn't."

The engine had quit.

"What I noticed was my father's sudden alertness, as if he had opened a million eyes and ears in every direction," Reeve said. "I don't remember fear at all. I do remember excitement. At last, something different was going to happen."

Charles shoehorned the Aeronca into a cow pasture, where Konecko took it apart and trucked it back to the hangar (no one, not even Lindbergh, wanted to try to fly it out). "I found out something about my father that afternoon, just watching him work his way down through the air," said Reeve. "I learned what flying was for him. He was concentrating hard, trying to put us in the best possible position for a forced landing. But he was doing more than that. He was persuading and willing and coaxing that airplane into doing what he wanted it to do, leaning it like a bobsled right down to where it could safely land. He could feel its every movement as though it were his own body. My father wasn't flying the airplane, he was being the airplane. That's how he had always done it."

Early on the morning of her reading, before the Museum opened, Reeve brought her youngest child, Benjamin Lindbergh Tripp, 10, to see his grandparents' airplanes, the *Spirit of St. Louis* and *Tingmissartog*, the Lockheed Sirius in which the Lindberghs made epic survey flights for Pan American Airways



COURTESY REEVE LINDBERGH TRIPP

IMAX CORP./LOCKHEED MARTIN

## AT THE MOVIES



*Mission to Mir is the newest IMAX film showing at the National Air and Space Museum's Langley Theater, and it offers many familiar sights: manned space vehicles blasting into orbit, mission control tracking a spaceflight, and astronauts floating in microgravity. But on closer inspection, you realize you're seeing things never before filmed by an IMAX camera. The movie opens with a scene at Baikonur, the once-secret Soviet launch site, where a Soyuz rocket is being readied for launch. Mission control is in Moscow, not Houston, and American astronauts Charlie Precourt, Bonnie Dunbar, and Greg Harbaugh sing "Moscow Nights" with a guitar-strumming cosmonaut (Gennady Strekalov) aboard a Russian space station named Mir (above).*

*The film is most compelling when it focuses on astronaut Shannon Lucid and her six-month stay aboard Mir—one episode of an ongoing cooperation between NASA and the Russian space program. Particularly engaging is the narration that Lucid provides throughout much of the film, telling us, for example, that fresh onions and tomatoes delivered by an unmanned supply vessel made for "one of the best meals I've ever eaten in my life." Later, we see her reading in front of a set of shelves that she has made out of empty food containers and bungee cord. Recounting that her daughter has sent her only the first volume of a two-part techno-thriller, Lucid confides: "That was the first time I realized a feeling of isolation."*

*For showtimes and ticket prices, call (202) 357-1686.*

in the early 1930s. Mother and son climbed into a cherry picker on the first floor and were hoisted up to the *Spirit* for a good look ("I've never even touched it," Reeve confided). After the two had spent a few quiet minutes peering in the cockpit and feeling the fabric skin, the basket descended jerkily and the passengers alit. Clearly it was a memorable visit for Reeve. And Benjamin? "He said, 'Gee, Mom, I've never been in a cherry picker before.'"

—Patricia Trenner

## Museum Calendar

*Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.*

**August 20** Marsha Ivins, a veteran of four space shuttle missions, will speak about her experiences as an astronaut. Ivins is one of 37 pilots featured in the "Women and Flight" photography exhibition in gallery 104. Einstein Planetarium, 7:30 p.m.

**August 30** "Star Stuff and Us." Steve Smith, director of the Arlington Planetarium, will use new images recorded by the Hubble Space Telescope to explain how the elements of life are manufactured in stars. Einstein Planetarium, 6 p.m.

**September 11** Native Alaskan bush pilot Ellen Paneok deals with everything from polar bears to extreme weather in her flights to remote Eskimo villages. She will talk about her experiences and the aircraft she has restored. Paneok is one of 37 pilots featured in the "Women and Flight" photography exhibition in gallery 104. Langley Theater, 7:30 p.m.

## Curator's Choice

Once a week a Museum curator will give a 15-minute talk about a particular artifact or item of interest. Aug. 6, giant landslides on Mars; Aug. 13, the *Enterprise* aircraft carrier model; Aug. 20, the Lilienthal 1894 glider; Aug. 27, the Messerschmitt Me 262. Meet at the Gold Seal in the Milestones of Flight gallery, at noon.



# Ghost Story

**T**he Douglas A-3B Skywarrior was on approach to the carrier, some 300 miles off the Philippines on a windy and moonless night. The deck had been cleared of the last of a flight of Chance-Vought F-8 Crusaders. All was ready for the A-3B, the last of our Carrier Air Group airplanes to be recovered that night.

It was February 12, 1963, and the *Ticonderoga* was headed for the Gulf of Tonkin for a six-month cruise. I had been assigned to Squadron VF-54 as the civilian technical representative responsible for the Allison engines in the McDonnell F-3B Demon. I was on the forward flight deck involved in a problem with one of the squadron's Screamin' Demons while the ship's crew recovered landing aircraft on the canted deck section. (I was never fond of being so dangerously close to airplanes roaring by or skittering to a halt after arrest.) The Skywarrior was an attack aircraft, initially used by the Navy as a bomber. Powered by a pair of Pratt & Whitney J57-P10 turbojets, it was the heaviest carrier aircraft in service at the time.

With 6,000 pounds of fuel, the A-3B on approach was considered to be in a low-fuel state, nearly down to "bingo"—just enough left to reach an alternate, or bingo, field, which for our location was Clark Air Base in the Philippines. Bingo for the A-3B was 5,000 pounds.

From the flight deck we could see the aircraft's navigation lights 10 miles out as the pilot attempted to get into the slot for landing. Though we could not see all of them, the many ships of the Seventh Fleet Task Force were out there, spread over miles of ocean, in coordinated movement with the *Tico*.

It had been a long day at Air Ops, beginning at 0430. We were anxious for the young lieutenant piloting the A-3B to land safely so we could go below, grab a bite, and get a few hours of sack time before rolling out and facing another long day.

He came in too high and was waved off. As the airplane roared by at full power, we became a little concerned. How much fuel was left now? He had to land soon. We got the word he was down to bingo fuel, or a little less. Trying to make the base would be iffy. But rather than heading for Clark, he began setting up for another carrier approach. Now, due to his fuel state, he was committed.

His next approach was too high and fast, and again he was waved off. He was well below bingo now. He had to make it aboard.

The third approach was high and fast. The pilot didn't need a landing signal officer to tell him that. He initiated his own wave-off, roaring over the deck and into the night. A successful recovery was beginning to look doubtful.

After a while we saw his nav lights out in the slot. This time, as he neared the ship, he was again high, and the nose was dropping as he neared the ramp. He slammed down on the deck, but his arresting hook missed the last wire and the aircraft bolted—took off again, struggled into a climb, and began a slow





turn, setting up yet another approach. Now his fuel was down to 3,500 pounds.

On the fifth try the airplane seemed too low. Though the pilot attempted a correction, the nose landing gear struck the aft end of the flight deck with a great flash. The impact sheared off much of the assembly, which came sliding down the deck. The debris tumbled along to the forward edge of the deck, some of it plunging over the side. The airplane's tail hook missed the arresting wires, and amid a shower of sparks from the nosegear stub, the A-3B roared by us and got airborne once more.

The pilot radioed that his hydraulic system pressure was zero, the flaps had crept up as a result, and he was unable to retract what was left of the nosegear. Rather than attempt a landing with the mangled gear, he was ordered to fly into the intersection of two searchlight beams from a couple of destroyers, then bail out with his two crewmen.

In the distance, two powerful beams pierced the night. The brilliant white shafts formed a big, bright "X" about 6,000 feet above the water and several miles off our port bow. Over the public address system came the order calling all available hands to the flight deck to watch for tracer rounds or flares from the crew that would signal their location.

In the darkness, the flight deck was soon a milling crowd of sailors, their eyes trying to adjust to the blackness after exposure to the bright lights below. Peering at the hypnotic "X" in the sky, we stood silently and waited.

The PA system blared: "All hands stand by! Bailout is imminent!" followed shortly by "The crew has bailed out!"

Suddenly, the beams of the searchlight disappeared. We strained our eyes in the direction of where we supposed the crew might be descending. A sailor pointed and yelled, "There! I think I saw a tracer." Another voice piped up tentatively, but we were all beginning to think we saw tracers—faint, random streaks in the blackness.

Destroyer searchlights came on, one after another, playing upon the water. Five minutes passed. I have never experienced such silence in the midst of hundreds of wide-awake sailors.

The PA suddenly came to life. "They have spotted all the crew in the water! They have spotted all the crew in the water!" There were cheers and whoops and laughter in the darkness, guys slapping one another on the back. In another 45 minutes the PA told us the three crew members had been recovered and were in good condition.

The happy crowd began to disperse. Suddenly a strange and urgent order rang out. "All hands get below the armor deck! Move! Move! Move!"

That was a new one on me. I started running with the others for the nearest watertight door leading below. Before I could reach it I heard the whine of jet engines. I looked toward the stern and saw navigation lights indicating an airplane inbound. But we had recovered all the airplanes that were able to land. And there were no other carriers in the area.

After a decent approach, an A-3B roared by, low over the deck, faintly illuminated by the ship's red floodlights. An A-3B minus much of its nose landing gear. An A-3B with no crew aboard. It looked quite stable, as if someone were expertly guiding it.

"Below the armor deck!" the PA urged. "Get below!"

We moved a lot faster now that we knew the situation. I began thinking I might just go several decks below the flight deck, like down in the bilge.

Instead I went to our squadron ready room, where pilots were relaying information from various onboard sources concerning the kamikaze A-3B. "It's inbound again," someone shouted. "The damned thing is heading right toward the fantail!"

We could not directly see or hear what was happening on the flight deck. Our information came via telephone and radio. We learned the airplane narrowly missed the ship. Now they were planning to launch the Grumman WF airplane—the "Willie Fudd"—which had a rotating radar dish sprouting from the top of the fuselage. Our onboard radar and that of the other ships seemed unable to determine the crewless A-3B's whereabouts, but the Grumman's radar operator might have better results.

The A-3B made another pass, seemingly right in the slot. It had been describing a left-hand oval pattern, passing across the ship on the lower side of the oval, then making a shallow climb until it reached about a thousand feet. After that it would go into a shallow dive, heading for the ship, which was steaming all the while, a moving target that the spooky A-3B seemed to have no trouble finding.

The Grumman finally launched, but its crew could not locate the A-3B. The ghost had disappeared (or was it just evading the Willie Fudd?). It never came back over the *Tico*, though we waited apprehensively for a long time.

No crash was ever observed and no trace of floating debris was ever found. The officer who wrote the accident report assumed that the Skywarrior had simply run out of fuel and dived into the Pacific.

Of course, that was only an assumption.

—O.H. Billmann



The fabulous life-like images of America's Premier Aviation Artist, Stan Stokes, are yours to enjoy. Please write or call us toll free for our 18 page FREE COLOR CATALOG.

**THE STOKES COLLECTION**

Box 1420 Pebble Beach, CA 93953

**1-800-359-4644**

## MISS AMERICA AIR RACING TEAM PRESENTS ARTIFACTS OF THE WILD BLUE YONDER



• Posters & limited edition prints by John Batchelor  
• Willis & Geiger leather flight jacket hand painted by Ron Kaplan • Highly detailed 1:48 scale die cast metal model by Marushin • Sportswear, wearable art & other artifacts of the Wild Blue Yonder

Free catalog **888-410-0206** toll-free call

MISS AMERICA  
SPONSORS &  
PARTNERS:

ndwell

AVIATION

Willis & Geiger

Visit us on the web at: [www.MissA.com](http://www.MissA.com)



# All That Jazz

**A**fter December 7, 1941, everybody in this country was urged every day—on billboards, radio, everywhere you looked or listened—to Remember Pearl Harbor. I remember Pearl Harbor all right but I remember with sharper clarity and poignancy the Sunday afternoon jazz sessions at Jimmy Ryan's on 52nd Street in New York in 1941, '42, and early '43, before the Army Air Forces called me into pilot training to Remember Pearl Harbor some more.

I first heard real jazz when I was a kid, and I was instantly addicted—not just to the beat and the sound, which were addictive enough, but to the force that drove the musicians. To me, the thrust of traditional jazz is an expression of that ongoing everyday miracle, the resilience of the human spirit. Jazz musicians were articulating—with exuberance—their triumph over the pain of living.

What I heard as a kid, of course, was recorded jazz. By 1941 I was 18 and old enough to drink legally and hear jazz live. I found Ryan's. I remember seeing and hearing Oran "Hot Lips" Page, Max Kaminsky, Bobby Hackett, Pee-wee Russell, Eddie Condon, Edmond Hall, Big Sid Catlett, George Wettling, Jess Stacy, Willie "The Lion" Smith, Jack Teagarden, Vic Dickenson, and George Brunies. I got to know some of them pretty well.

Eddie Condon and his tireless vocal cords were in the forefront of the jazz world by the time I was called into uniform. While I was still in pilot training, far from 52nd Street, Eddie achieved worldwide fame with his Town Hall Concerts, broadcast weekly from coast to coast. They were also recorded and played often over Armed Forces Radio for millions in uniform.

I never had a radio in my tent in France or my room in Belgium.

The only time I heard Armed Forces Radio was when I happened to be flying some rare non-combat chore. On combat missions you were supposed to stay tuned to your group's own frequency and maintain radio silence.

One day toward the end of the war, on the way back from what had turned out to be a milk run over Germany, I switched from the operational frequency and found AFR. What hit me through the earphones was Max Kaminsky's cornet on a chorus of "Baby Won't You Please Come Home," followed by Pee-wee Russell's clarinet. It was an Eddie Condon Town Hall Concert.

I was flying Number Two, on the right wing of the leader of my flight of Douglas A-26s, somewhere over Mannheim, heading home to Belgium and trying to figure out who was on trombone, when off my right wing I saw another A-26 where there wasn't supposed to be one. I saw something else that wasn't supposed to be there—flak, scattered black puffs of it, hanging in the air all around. We were being shot at, and I was too immersed in

"Baby Won't You Please Come Home" to realize it.

The pilot to my right, Junior Thompson, was waving at me. I switched back to the operational frequency.

"What is it, Junior?" I asked him.

"Your left engine," he said. "It's pissing." I looked. It was. Oil was coming out from under the cowl flaps in scattering streams.

"Thank you," I said, and slid out of formation. I cut the left engine, feathered the prop, turned the radio to the Mayday frequency, and called. I didn't expect an answer. Calling Mayday only worked in the movies and in training films.

But I got an immediate clear response. I said I was an A-26 on single engine. "What's your heading and airspeed?" Mayday wanted to know. I read off the numbers and Mayday was back in 30 seconds. "Fly a heading of 240 for 16 minutes," Mayday said, "and you'll have an airstrip in sight."

I found it: a P-47 fighter field with a 3,000-foot runway. We thought we needed all of 5,000 feet to land the A-26, but the runway was made of metal grating that slowed me down.

The P-47 had the same Pratt & Whitney R-2800 2,000-horsepower engine as the A-26, so the mechanics were able to put in a new oil line to replace my shattered one while my gunner and I ate a Spam sandwich. I was back in Belgium before the bar in the club opened.

That Town Hall Concert day was one of the few times I ever got close to real trouble over

Germany. It took me 20 years after the war to realize that jazz was hazardous to my health—listening to it and drinking with musicians half the day and night.

I should have gotten the message over Mannheim.

—Arnold Benson





# YOUR BEST VALUE IN A 1998 DESK CALENDAR!

NOW WITH  
QUANTITY  
DISCOUNTS!

## The Official 1998 Air & Space/Smithsonian Desk Calendar

A genuine "exclusive" bargain produced in limited quantities, the 1998 edition of the official AIR & SPACE/SMITHSONIAN Desk Calendar will soon be ready for delivery.

Printed entirely on heavy, burnished stock and richly hardbound, this distinctive desk accessory is more than a combination calendar and daily planner.

Featured throughout are over 50 rare photographs drawn largely from the National Air and Space Museum's famed archives and including many never published before. There's also detailed photo caption information and noted aviation anniversaries. Together, they capture the spirit of flight from its wood-and-wire beginnings to today's most advanced aircraft and space vehicles.

Available shortly, this special-edition 1998 desk calendar may be ordered for a modest \$13.95 including shipping and handling.

*Quantities at this price are definitely limited.*

*So order now to guarantee delivery in time for the holiday season.*

Please complete the form below and send in with your payment:



**STRIKINGLY  
ILLUSTRATED!**  
Photos from the  
Smithsonian's National  
Air and Space Museum  
Archives!

MAIL ORDER TO: Air & Space/Smithsonian, 901 D Street, SW, 10th Floor, Item #A98D, Washington, DC 20024.

Phone 1-800-824-5974 toll-free to leave a recorded message with credit card and mailing information, or fax to: 202-287-3163.

- ☐ one desk calendar @ \$13.95 (all prices incl. S&H)    ☐ two desk calendars @ \$25.95 (save \$2)  
☐ three desk calendars @ \$37.95 (save \$4)    ☐ four desk calendars @ \$47.95 (save \$8)  
☐ five desk calendars or more @ \$11.00 per calendar (save \$15+)

☐ This calendar order is for use as a 1997 holiday gift.

☐ Check or money order enclosed

Make check payable to: Air & Space/Smithsonian

☐ Discover

☐ Mastercard

☐ American Express

☐ VISA

Credit Card # \_\_\_\_\_ Exp. Date \_\_\_\_\_

Signature \_\_\_\_\_

MAILING ADDRESS (please print):

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Above quantity discounts available for delivery to one location. U.S. shipping of the 1998 Desk Calendar will begin November, 1997 to accommodate 1997 holiday gift orders. Please allow up to 4 weeks for delivery. For international surface delivery beginning September 1997 add \$2 for each calendar ordered.







# THE RECON STRUC TION

by William Triplett

*Illustrations by David Povilaitis*

On the morning of January 10, 1954, a de Havilland Comet operated by the British Overseas Airways Corporation departed Rome's Ciampino Airport on a flight to London. After a smooth takeoff, the Comet, registered as G-ALYP, began a swift ascent through overcast skies to its cruising altitude of 36,000 feet. At 10:51 a.m., as the airliner passed 26,000 feet, radio contact between G-ALYP and the control tower abruptly ceased. Moments later, fishermen near the island of Elba saw the jet rain down over the Mediterranean in hundreds of fiery pieces. Six crew members and 29 passengers had died.

The Royal Aircraft Establishment began a four-month investigation, making the ambitious decision to painstakingly reconstruct the fragmented airliner

on a rounded wood frame. The decision proved wise. As G-ALYP came together, investigators noted several clues: an impression of a coin in the airliner's outer skin, cabin carpeting embedded in the tail, and a mark on the outer surface of the tail made by a rubber compound from the passenger seats. Based on this evidence (as well as other studies of the Comet fuselage), investigators concluded that G-ALYP had experienced an explosive decompression of its pressurized cabin, which had hurled

What can the careful assembly of wreckage reveal about air disasters like TWA Flight 800?

its contents outward. What had caused the decompression? G-ALYP's thin aluminum skin—subjected to the flexing of numerous pressurization-depressurization cycles—had become fatigued. And that had led to a fatal crack (which investigators designated “the origin of failure”) in the upper fuselage.



Forty-three years later, the reconstruction techniques pioneered by the British have been taken up by an equally hopeful team of investigators who are working to solve the mystery of TWA Flight 800, an air accident that has left expert and amateur alike wondering what brought down the Boeing 747-131 on a flight from New York to Paris last summer.

There are many similarities between the last moments of G-ALYP in 1954 and those of Flight 800 in 1996. After taking off from runway 22 Right at John F. Kennedy International Airport at 8:19 p.m. on July 17, the 747 (registration N93119) headed out along the Long Island coast, ascending to 13,700 feet about 12 minutes later. At this point radar contact was lost. Flight 800's last radio communication had been made about a minute before: a routine acknowledgment of clearance to climb to 15,000 feet. Like the Comet, N93119 was loaded with fuel, and it broke apart into masses of burning wreckage, which landed in the Atlantic 10 miles from shore. All 230 people on board were killed.

When investigators at the National Transportation Safety Board got word of the accident, they knew right away that they'd be trying to put at least some of the jumbo jet back together. "On every accident we try to do some reconstruction work," says Lawrence E. Jackson, a 46-year-old civil engineer now in his 20th year with the NTSB. "It's a tool you use to help determine probable cause."

A reconstruction can be especially valuable when an aircraft breaks up in flight, as did the Comet and Flight 800. And though the resulting accident sites have morbid similarities, every shattered airliner has its own pattern of failure—a final imprint that skilled investigators can use to determine how and why an airplane came apart.

"The natural human thought process is to envision an airplane part straight up—the way it would sit in a wing-level, right-side-up attitude," says Jeff Guzzetti, an NTSB air safety investigator based in Seattle. "But many times that's not the case. You'll have components that are inverted. Or they're turned around and twisted. And that's when reconstruction does help. It helps you

identify where that part came from and what orientation it was in."

The most common type of reconstruction is undertaken at a level below the major media's radar. Each year in the United States, more than 2,000 small, privately owned airplanes have accidents. For a major commercial accident like Flight 800, the NTSB will send a "Go Team" consisting of 15 or more air safety investigators from its headquarters in Washington, D.C. (see "The Go Team," Aug./Sept. 1987). General aviation accidents, however, are usually handled by an NTSB field investigator, some 45 of whom work in the board's 10 offices around the country. "I'm a one-man Go Team," says Guzzetti. Yet his investigations—in-

"There were pieces  
that had soot and  
fire damage, the

cluding the reconstruction phase—are in principle no different from those of the larger team.

Guzzetti, a 35-year-old investigator with a commercial pilot's license, remembers particularly well a case he worked more than three years ago. On April 16, 1994, a single-engine Piper broke up over Salem, Ohio, and to this day, Guzzetti carries an image of the reconstructed airplane in his mind as if it were a picture in his wallet.

"It was a miserable evening," Guzzetti recalls. "It was rainy and cold, and the airplane came apart over a wooded area." The investigator knew that when airplanes break apart in flight, the likely cause is either a fire, an explosion, or a structural failure. Still, he was careful not to settle on anything too soon.

He spent four days mapping out the wreckage (which was scattered over three-quarters of a mile) and collecting it with the help of 50 volunteers. Working in a nearby hangar for two days, a four-member team, consisting of Guzzetti

and three representatives from the Federal Aviation Administration, completed a two-dimensional reconstruction—laying the pieces on the floor as opposed to mounting them on a frame. They pieced the aluminum-skin Piper together using a technique based on intuition and trial and error. "There are ribs and longerons and stringers and fuel lines that are kind of dangling out," recalls Guzzetti of the airplane's fragmented fuselage. "And you try to find a marrying surface that has the same type of ribs and fuel lines."

As Guzzetti pored over the reconstructed Piper with notebook and flashlight in hand, he looked for the characteristic signatures of structural failure (he had found no evidence of fire or an explosion). Perhaps the Piper had come apart due to repetitive stress, such as aerodynamic flutter. Or maybe it had been felled by overload failure. ("Just one big yank," says Guzzetti.) The investigator was also on the lookout for "shear lips," sharp edges next to the

kinds of things  
you'd expect in a  
major explosion."

fracture points, as well as metal fatigue, which develops over time and shows up as "beach marks," small radial marks that look like the traces left behind by water washing up on the shore.

Studying the Piper's fracture surfaces, Guzzetti saw no signs of metal fatigue, leading him to suspect that strong G forces had ripped the airplane apart, starting with the tail. The left and right horizontal stabilizers had experienced negative-G loading: A strong downward force had snapped them off. The tail's vertical stabilizer had broken off due to a torsional, or twisting, load. The Piper's right outboard wing was bent upward until it had fractured, while the left wing was pushed down until it too had failed. Then the fuselage had come apart, and Guzzetti noted that the rivets used to fasten the skin had stretched



out like taffy, evidence of tensile overload.

"It was a chore to document the failure modes of all those parts," says Guzzetti, but the finished job had shown him how the Piper's parts had fractured and in what order the failures had occurred. But the question remained as to what event or series of events had precipitated the breakup. A final report issued by the NTSB's five-member safety board stated the probable cause to be "loss of aircraft control due to [the pilot's] spatial disorientation, and exceeding the design stress limits of the aircraft." The pilot had flown directly into clouds, rain, and darkness. These conditions require a pilot to rely on instruments, but this flier was not rated for instrument flying. No doubt disoriented by the lack of visibility and confused as to the true orientation of his aircraft, the pilot probably acted hastily, perhaps even panicking. Radar data shows that the Piper made a rapid descending turn from about 5,700 feet just before radio and radar contact ceased.

Guzzetti says that the reconstruction of the Piper was "absolutely necessary" in helping the five-member board determine the accident's probable cause. And without having the reconstruction to constantly refer to, he says it would have been impossible for him to make sense of the Piper's myriad fractures. "You simply couldn't do it," he says. "The geometry and the fracture surfaces are just too complex and intricate for one human mind to envision without seeing it all there in front of you."

Two months after Flight 800 went down, the NTSB's Larry Jackson was summoned to a hangar in Calverton, Long Island, that formerly belonged to Grumman Aircraft. On the floor of the hangar his colleagues had arranged pieces of N93119's center fuel tank, which they believed to be the origin of the explosion. "There were pieces that had soot and fire damage, the kinds of things you'd expect in a major explosion," recalls Al Dickinson, the NTSB's investigator-in-charge for Flight 800. "No other area of the aircraft had this kind of damage and destruction."

Something had blown up the nearly empty center fuel tank. But what? The news was full of speculation that either

a bomb or a missile had been involved, though no substantive evidence existed in the wreckage to support either theory. At that point investigators started talking about doing a full, three-dimensional reconstruction of the fuselage area both fore and aft of the tank, if for no other reason than to see if it would rule those theories out.

But while the NTSB had done numerous reconstructions, the agency had never attempted one so extensive

for a wide-body jet. In fact, no one in the world had. Investigators were talking about reassembling more than 90 feet of fuselage. The largest reconstruction to date was some 60 feet of Pan Am Flight 103, a 747 reassembled by the British after it had been blown apart by a terrorist bomb over Lockerbie, Scotland, in 1988. "We decided that before we did anything," Jackson says with a faint smile, "we would go to Britain to see how they'd done theirs first."



*British investigators discovered that metal fatigue at the corner of a window frame led to the Comet's catastrophic failure in 1954.*





*Reconstructionists assembled some 60 feet of Pan Am Flight 103, a 747 that blew apart over Lockerbie, Scotland.*



In the meantime, the collection of the fragmented airliner continued. Since the pieces were under 120 feet of water, the retrieval operation went slowly, but after nearly 10 months of trawling a circle of the Atlantic about five miles in diameter and salvaging pieces that ranged in size from 30 by 30 feet to no bigger than a dime, the U.S. Navy hauled up approximately 95 percent of the destroyed airliner.

As the wreckage trickled in, it was examined by FBI and FAA bomb specialists. Then the National Guard loaded the salvaged pieces onto tractor-trailers, which were escorted by a line of slow-moving emergency vehicles, making the convoy traveling from the Long Island shore to the hangar at Calverton look like a lumbering funeral procession. Once off-loaded, the pieces again fell under the scrutiny of the FBI and the FAA. Only afterward could the NTSB begin its work.

Identifying bits of wreckage is always tricky, but when it involves something the size of a 747, the job can be maddening. If an investigator is lucky, says Jackson, a piece will be identifiable—despite any severe damage or mutilation—through its serial number or its station number, the latter a stamp that the manufacturer puts on a part indicating its distance from the nose of the aircraft in inches. A part stamped “Station 100,” for example, means the part is located somewhere on the fuselage 100 inches back from the nose.

Thickness is also a good indicator of a piece’s identity. “The thicker the item, the more load-bearing capability it has,” says Guzzetti. Paint finish can help determine whether a piece came from the top or bottom of the aircraft: The paint on top will be dulled somewhat from constant exposure to the weather.

Whatever the method, the idea at this point was just to get each part logged in, note its condition and the exact location where it was found (in this case, its latitude and longitude on the bottom of the Atlantic), and then move it onto the floor of the hangar, where a grid the same scale as the 747 had been laid out as a blueprint for an initial two-dimensional reconstruction.

Often the best that can be done for any piece at this stage of the investigation is to determine the general area

it probably comes from—the lower left fuselage, say, or upper tail assembly—and move it to the appropriate area on the grid, where the more detailed identification happens. “You don’t want thou-

“It was like trying to  
sort out a puzzle  
when we only had  
65 percent of the

sands of pieces stacking up on your front porch,” says Roy Hurlbut, 40, a Boeing aeronautical engineer who helped in the TWA 800 reconstruction. “You’ve got to keep the process moving.”

In the beginning, the whole investigative process was moving around the clock. Even as things settled down, Hurlbut remembers, the typical day began around 6:00 a.m. and didn’t end before 6:00 or so that evening. During those 12- and sometimes 14-hour days, everyone worked in groups of three or four—the structures group, the powerplants group, the systems group. An NTSB investigator headed up each group, reporting regularly to Dickinson, the investigator-in-charge.

Working in the various areas of the grid, groups of investigators used micrometers, calipers, tape measures, flashlights, pencils, notebooks, and engineering drawings to determine a piece’s specific identity and location on the aircraft. If only part or none of the station number was present or legible, “that’s when it really [got] to being like a jigsaw puzzle,” says Hurlbut, who looked at sometimes hundreds of pieces a day, trying to figure out exactly what they were. A total of some 100 people ended up working on the whole reconstruction process, but on any given day only about 10 to 15 were on the floor turning over pieces in their groups’ areas.

Much time was spent telephoning and faxing requests to manufacturers

for data that could help in the ID process. It was tedious, meticulous work that was often frustrating. “When you’re looking at pieces that are coming in and they’re not the ones you need, you want to say, ‘Don’t bring me those 40,000 parts, bring me the ones I need!’” says Hurlbut, a tall, usually easygoing engineer who assisted the British in the investigation and reconstruction of Pan Am Flight 103. “And when your time on site turns into several months, it can take a toll on you. After a while your

pieces, and then they  
threw in pieces from  
two other puzzles.”

things at home start to fall apart—your mortgage payment is late, your car needs something. All you can do is keep your eye on the goal, which is to figure out what happened. Because you don’t want it to happen again. That’s what keeps you going.”

The team was particularly challenged when it came time to lay out the honeycombed fairings from the 747’s underside. Fairings are exterior surfaces that cover the areas where sections are joined—in this case, the wings to the fuselage—to make the final form aerodynamic. The salvage crews had found only about 65 percent of the fairings. Worse, the pieces were mixed in with honeycombed material from two other sections of the airliner. “It was like trying to sort out a puzzle when we only had 65 percent of the pieces, and then they threw in pieces from two other puzzles,” says Jackson. “We were real excited whenever we figured out a piece.” Jackson got a big hand from a 747 mechanic (the NTSB frequently asks for help from maintenance people familiar with the type of aircraft being studied). “He could go through and tell by the shape of the honeycomb whether it was from the [underwing] area or not.”

One of the biggest assists came from REDARS—the Reference Engineering



Oct 1978. Approximately 35 minutes after the crash of USAir Flight 427, smoke from the wreckage can be seen rising at sunset.



*USAir Flight 427, which dove into the ground near Pittsburgh, was so fragmented that investigators could reconstruct only small sections.*

Drawing Automated Retrieval System, an online database maintained by Boeing. If even a partial number was legible on a piece, it could be entered into the system, which then supplied not only the likely suspects but a drawing of what each looks like. (REDARS made its debut in wide-body reconstruction with Flight 800.)

When using the database, an investigator typically sat before a computer, a chunk of 747 between his knees as he silently scrolled through drawings looking for the one that would tell him what the piece was and where it came from. Whenever the engines powering the overhead cranes lifting slabs of jet weren't roaring, the prevailing atmosphere in the fluorescent-lit hangar was

one of quiet, intense study, with a dozen or so people scattered about, trying to make sense of chaos one piece at a time.

Sometimes investigators find meaning in the wreckage even before it gets pieced together. This proved to be the case with the Pan Am Flight 103 accident scene at Lockerbie. "I stumbled across these first bits on site and looked at them and thought, *Oh, my goodness!*" recalls Chris Protheroe, a senior inspector with Britain's Air Accidents Investigations Branch (AAIB). "They were fragments of a cargo container and they had traces of pitting and sooting. I've done a lot of investigations of airborne breakups and fires, and I knew that what I was looking at was not consis-

tent with what I'd expect from a conventional airborne fire."

AAIB investigators laid out every piece of fuselage and tail plane they could find and identify for a two-dimensional reconstruction. Their attention fell on the left side of the forward cargo hold, on an area roughly 18 inches square for which they had no pieces. "We had almost all the rest of the aircraft and could jigsaw it all back together in the 2-D reconstruction," says Protheroe. "But one of the few things we did not find was this one part in the area of main interest. The missing area looked as though you had taken a large shotgun and fired a hole from inside the cargo deck, just blasting a hole through the fuselage."

Simultaneously, AAIB investigators had done a three-dimensional reassembly of the suspect metal cargo container. They observed a particular pattern of damage on the floor and walls of the container, which indicated that the blast had originated inside it—not externally. Damage to the container and its position in the cargo hold even matched up with the hole in the airframe. Investigators also noted fracture lines in the airframe radiating out from the hole. Pan Am Flight 103 had experienced an explosion, and investigators now knew exactly where it had taken place.

These findings, however, raised a crucial question. "The size of the hole—about 18 inches—when you looked at it against the scale of the whole aircraft, it was like a pinprick," says Protheroe. "We had a lot of trouble trying to make the connection from this small hole to the total and very obviously complete disintegration of the aircraft."

The AAIB felt there was only one thing to do: Examine the fuselage in three dimensions. Protheroe designed a framework made of steel tubing to hold approximately 65 feet of reassembled fuselage—30 feet or so in front of the "pinprick" and 30 or so in back. Investigators then drilled holes in a piece, inserted a hook-bolt, hung it on the tubing, and clamped the hook into place. If a piece was bent or sheared, extreme care was taken to attach it by its last point of contact with the fuselage. "Imagine detonating a device inside the fuselage and the [fuselage] panels tearing off," says Protheroe. "If you were to sort



of video that and freeze frame the instant just before the pieces are about to separate for good—I was attempting to mimic that instant in time.”

It proved the key to resolving the last question about what had happened to Flight 103. Unlike the 2-D view, the 3-D showed the way in which large fuselage panels adjoining the area of the blast hole had curled and petaled outward, eventually separating. This enlarged the original puncture from a mere 18 inches to some 17 feet in circumference—large enough to cause the subsequent disintegration of a pressurized airliner flying approximately 500 mph at 31,000 feet.

Ten months after Flight 800 broke up, the salvage operation ended, and

“I think the real  
motivation [was]  
to reassure the

now that the flow of wreckage had ceased, the investigating team was able to complete the 2-D reconstruction. Unfortunately, it yielded no clues to what had caused the center fuel tank to explode, though it did confirm that a substantial blast had occurred there. “There were five separate compartments inside the center tank,” says Al Dickinson, another 20-year veteran with the NTSB and a former commuter airline pilot. “And they all showed major damage,” along with extensive pitting and sooting.

Investigators had decided early on to examine the tank further, and five weeks after the accident, they bought metal scaffolding and erected two separate structures to hold pieces of the tank—one for a 3-D reassembly of the bottom of the tank, the other for the tank’s top and vertical walls, thus making each area of the tank viewable. Before the explosion, the tank, which forms the center section of the wing, measured 20 feet long, 21 feet wide, and

about 6.5 feet deep at the front. It tapered back in the shape of an airfoil to about four feet deep at the rear.

Over the course of about two weeks, an average of 10 investigators worked daily, hanging some 350 pieces. In addition, on a third scaffolding they reassembled a small portion of the fuselage area near the front wall of the fuel tank. Together, these three limited 3-D reconstructions confirmed more or less just one other suspicion: The directional patterns of damage showed that the forces of the blast had gone forward.

At that point, there was debate about what the next step should be. “A lot of our technical people didn’t want to do the [larger] reconstruction,” says Tom Haueter, 45, a 13-year NTSB veteran who holds a degree in aeronautical engineering from Purdue University. “They felt like we’d seen all we needed to see.” The site of the explosion (the center fuel tank) had been revealed by both

American public  
that we don’t have  
evidence of a bomb  
or missile.”

the 2- and 3-D reconstructions, and the subsequent disintegration of the airliner posed no serious questions, as it had with Pan Am Flight 103. Finding the *cause* of the explosion was now the main priority, and many investigators didn’t believe that would be revealed through reconstructing anything beyond the immediate area of the blast.

But other agencies involved in the investigation, such as the FBI and the Bureau of Alcohol, Tobacco and Firearms, lacked the NTSB’s experience with air disasters and felt they needed to see more—as did, in a way, the public. “I think the real motivation [was] to reassure the American public that we don’t have evidence of a bomb or mis-

sile,” says Shelly Hazle, an NTSB spokesperson. “Which is hard for people to visualize when it’s all on the floor.”

During their preparatory visit to Europe, Jackson and two colleagues visited not only the 3-D reconstruction at Lockerbie but one the French had done for a UTA airliner blown up over the African desert in 1989. They paid particular attention to the supporting structures designed and used for each, and felt the structure used by the French—principally solid steel I-beams—would be better for holding some 65,000 pounds of wreckage than the steel-tube scaffolding the AAIB had used. Realizing they might one day have to move the structure, however, they adopted the AAIB’s inclusion of wheels.

To build the structure, the NTSB hired a contractor, Wiss, Janney, Elstner Associates, a Chicago-area engineering firm that had experience not only with bridge construction but with investigations involving bridge reconstruction. Wiss, Janney designed a structure 110 feet long—basically a steel railroad truss bridge. Three trucks brought girders and beams from a manufacturing plant near Syracuse, New York, to Calverton.

Haueter was awestruck when he first saw the structure in place. “I’d seen the drawings and knew what they were going to do, but when you first see the thing—the size of it,” he marvels. “I mean, I thought, *Wow! This thing is huge!* It seemed just bigger than I’d anticipated by a factor of 50 percent.” Because of the welding involved during assembly, local firemen stood by as a precaution. One of them, noting that the framework resembled the ribs of a large animal, christened it “Jetosaurus Rex.” The name stuck.

The structure’s beams had been pre-punched with holes every four inches. Starting last January, the contractor had three employees (sometimes as many as five) attaching pieces by drilling a hole through them and then securing them to one of the pre-punched holes with either wire or a nut-and-bolt assembly. The NTSB and FBI supervised the proceedings and also operated the overhead cranes; representatives from TWA and Boeing helped determine the best placement of individual pieces.

Like every other part of the investi-



gation, the 3-D reconstruction followed a systematic approach. "We have three different zones—red, yellow, and green," explains Jackson. The red zone was the section of the aircraft that fell first (in this case the area immediately forward of the center tank); yellow was the section that fell next (the front fuselage); green denoted a "cool" area, or the section that traveled the farthest (everything above and behind the center tank). The investigators started with the top of the fuel tank and worked their way

"Theories will be cropping up all the time. It will be a lot

through the green zone toward the rear of the jet. "We thought the red and yellow zones were more critical," says Jackson. "So we thought that if we worked backward, we'd build up experience so that we could do the best job possible when we got to those critical zones."

Next they did the red zone, then concluded with the yellow. Again working 12-hour days—12 days at a stretch, followed by two days off, for three months—the team ended up with a record-breaking reconstruction. The behemoth was 92.7 feet long, 30 feet high, and held a total of 876 pieces (including the center tank's 350 pieces). Counting all work from the beginning of the investigation, total hours for the reconstruction numbered an estimated 10,000.

The final assemblage didn't reveal the cause of the explosion, but it did, as expected, further discount the likelihood of a bomb or missile having been involved. Not only was microscopic trace evidence lacking on any of the pieces, there was no likely blast hole or point of entry.

Still, the reconstruction helped by shutting down fruitless avenues of investigation—no small concern when the total tab pushes \$100 million, as it did with Flight 800. Better yet, the reconstruction may steer investigators

toward the ultimate cause via a process of elimination. Such was the case in the investigation of USAir Flight 427, a Boeing 737 that crashed just outside of Pittsburgh in 1994 while preparing to land. The airliner went into the ground nose-first at an angle of about 85 degrees and a speed of 300 mph, leaving little for investigators to work with. "Our biggest piece was the tail," remembers Tom Haueter. "But the front of the plane was just fragmented."

Haueter and other investigators knew that the jetliner had gone into a sudden yaw while descending through 6,000 feet, which turned into a roll that preceded the fatal downward plunge. Three theories were proposed early on: a cab-

easier to check into them when the pieces are all hung."

in floor beam had collapsed, pulling down the rudder control cables running underneath it, thus producing a sudden rudder deflection, which had caused the yaw; a large bird had come crashing through the radome and then the forward pressure bulkhead, tangling the rudder cables; or the auxiliary fuel tank in the aft cargo area had come loose and tangled or severed the cables.

After identifying as many pieces as possible and laying them out in 2-D, investigators did a 3-D reconstruction of the fuel tank, the cabin floor beams, and the forward pressure bulkhead. (They also had the Armed Forces Institute of Pathology test for bird remains.) The work was even more tedious than usual, given "the incredible devastation," says Haueter. "Some of the floor beams we could never identify more than 25 percent of."

The team worked two shifts for six weeks. Based on the reconstructions, each theory was eventually ruled out; investigators noted no damage to or interference with the rudder cable from

foreign objects. As a result, they have been able to concentrate their attention on the design of the actuators in the 737's rudder system. (The investigation remains open.)

Similarly, investigators of Flight 800 benefited substantially from the full-scale 3-D reconstruction. For one thing, they gained valuable experience in the art and science of reconstruction. "We're immensely proud of what we did," says Dickinson. "Even NTSB people who come up here and look at the thing for the first time say, 'Wow!'" The finished job will also serve as something of a reference library for future investigations that involve reconstruction, showing not only how it's done but the kinds of clues and information a large-scale reconstruction can and cannot reveal.

Most important, however, the NTSB says its investigators will be using the Flight 800 reconstruction to validate or refute future theories. "Theories will be cropping up all the time," says Dickinson. "It will be a lot easier to check into them when the pieces are all hung up on a large frame as opposed to being on the floor." (The NTSB continues to look for what ignited the center fuel tank, and the possibilities that the agency is studying include: an electrostatic spark, an electrical short circuit, an overheated fuel pump, a small explosive charge, and an object that hit the airliner, such as an engine part, a meteorite, or a piece of space debris. Last spring investigators detonated missile warheads at various distances from airliner skin; none of the resulting damage patterns, however, were observed anywhere on the recovered wreckage of Flight 800.)

The investigators remain hopeful that the exact cause of the Flight 800 accident will eventually be identified. "There's a lot riding on these investigations, so we don't want to be precipitous," says Dickinson. "It's not like we're giving up. We're not at all scaling back. It's just that the areas we've covered have not revealed a cause. You can't expect a speedy answer all the time."

In the meantime, the reconstructed 747 sits in the old Grumman hangar at Calverton, waiting to confirm a theory held from the beginning or, possibly, to reveal a completely unforeseen probable cause. ➤





*Drawing from the wreckage of TWA Flight 800, workers reconstructed the shattered fuselage out of 876 pieces.*





by Patricia Trenner

Photographs by Caroline Sheen

# Summer

“Coming up on the right is Jockey’s Ridge,” Chuck Turner shouts over the clatter of the Cessna’s engine. “It’s the longest natural sand dune on the U.S. coast. It changes shape throughout the season.” Turner banks the four-seat 172 so the passengers get a good look at the hang gliders launching off the dune. Crossing over Roanoke Sound, Turner points out the village of Wanchese. “The sound is only five feet deep in most places,” he says. “Wanchese needed a channel, so they dredged out 14 feet and deposited the sand on Roanoke Island. They sell it to homeowners on the beach. Sand is one of the best selling products on the Outer Banks.”

Coming down the home stretch of the 25-minute sightseeing flight over North Carolina’s barrier reef, Turner points out Andy Griffith’s house in tiny placid Manteo—“No, really, he lives there”—and enters the traffic pattern at Kill Devil Hills’ First Flight Airport. The perpetual low-level turbulence at the approach end of the south runway rocks the Cessna, and Turner wrestles with the controls to make a soft touchdown. After his passengers alight, Turner escorts them off the tarmac and signs a “First Flight” certificate for each before they trudge up the hill to the Wright Brothers Monument.

This flight was the first of Turner’s day: one down, at least a dozen more

*Picture-perfect at Kitty Hawk Aero Tours: Scott Challice gives the passenger in his Waco biplane a postcard view of the Wright Brothers Monument, while Mark Pfister snaps his passengers for their scrapbooks (above).*





Three months in the lives of a group of young pilots determined to pump up their logbooks.

# Hours



to go for him and each of his nine fellow pilots on air tour duty before dusk curtails the flying. It's early in the 1996 season and the temperature will hover around 80, acclimatizing the fliers for a hot, hazy August. Like most days, there will be no lunch hour or coffee break—just 10 hours' worth of big loopy racetracks over the Outer Banks, telling perspiring tourists about the Wanchese Channel, Jockey's Ridge, and Andy Griffith's house.

Turner and his co-workers have come to Kill Devil Hills not for the beach but to build time—logging hour after hour of pilot-in-command time toward an Airline Transport Rating. For aspiring airline pilots, time is truly money—a long-term investment—and the hour is the unit of currency.

To qualify for an Airline Transport Pilot rating, the Federal Aviation Administration requires you to be at least 23 years old, a high school graduate or equivalent, able to read, write, and understand English, and in possession of "good moral character." You also need a commercial pilot certificate and 1,500 hours of flight time. That's just to take the FAA test. The airlines, flooded with applications from highly qualified fliers, have their own extensive requirements.

Most civilian pilots get their initial license—private pilot—by renting an airplane and hiring an instructor, then accumulate enough pilot-in-command time and experience to start moving up the ratings ladder—commercial pilot, instrument, flight instructor, multi-engine. Racking up those hours usually entails getting a blue collar flying job, anything that keeps you in a cockpit. You can teach, or tow banners, or find a tourist town with an airport that offers sightseeing flights. There are flightseeing operations in Hawaii, Alaska, and at the Grand Canyon, and there is Kill Devil Hills, where Kitty Hawk Aero Tours owner Jay Mankedick has a perpetual stack of applications from all over the country.

Mankedick, a compact man of 52 with bright blue eyes, a deep tan, and an ever-present baseball cap, has been giving sightseeing rides at First Flight airport for 20 years. "Back when I was building the business it was not uncommon for me to do 24 flights a day," he says. "But that gets old." Kitty Hawk



Aero Tours, with around 10 pilots, now operates as a concession of the National Park Service, which runs the Wright Brothers National Memorial museum next door to the airstrip. Mankedick requires 500 hours for his pilots, twice what the FAA says is appropriate. "They've been flying commercially for two or three years and come to me with a signoff from the FAA, but they have to pass my inspection," he says. First Flight's relatively short 3,000-foot strip can be a challenge, and there's that constant turbulence at the approach end of Runway 20. But Mankedick's inspections go beyond flying ability. An Aero Tours pilot has to be good with people—customers as well as fellow pilots—and has to bring something to the party, "an additional talent like computers or mechanical or even piano playing for entertainment," Mankedick says.

*Aero Tours pilots make the Shed presentable for an impromptu party (below) and turn an airy bedroom for three into a sound stage (above). For the young and the broke in Kitty Hawk, says Chuck Turner, "this is 'Cheeseburgers in Paradise.'"*



A summer as an Aero Tours pilot is a kind of flier's boot camp. Waking hours are spent flying and tending to the nine blue and gold Cessnas and their passengers. Life revolves around the Shed, Mankedick's ramshackle boarding house and matching trailer on a stagnant stream ("waterfront property," its occupants call it), where pilots rent living space for \$15 a week; the Booth at the airport, where the rides are sold; the Hangar, Mankedick's Outer Banks Airways charter operation at Dare County Regional Airport in Manteo; and the Barn, Mankedick's house on Kitty Hawk Bay, where barbecues and end-of-season parties are held. At \$5 an hour, pilots barely make beer money, and with a 70-hour work week, there's little time to drink beer. "This is," says Turner, "'Cheeseburgers in Paradise.'"

This summer six pilots occupy the Shed, which has one bathroom, a cranky water heater, and many mosquitoes. Rules in the *Aero Tours' Pilot's Handbook* govern Shed life: "Sorry, no air

conditioning units allowed.... Please respect others' property and privacy. We've all got to live together.... No one gets their own room unless management has set it up.... No whining! We expect employ-

ees to be able to handle these arrangements without management interference. If dissatisfied with these living arrangements, you of course are free to rent your own place."

There are also rules for behavior around customers as well as airplanes: "If given a specific time to be at First Flight, you should be at the booth ready to take customers at that time, not just touching down or having to do windows.... Do not ask to run errands or make food runs while on standby.... Pilots are expected to stay up front and available. Every customer who walks by should be greeted in person at the bottom of our walkway.... While at the booth, there will be no rude comments about customers, and no war stories or foul language.... There is a \$30 fine for leaving a master switch on."

Chuck Turner is a Shed squatter, having wintered over the previous year, solo. He had hoped to log charter time over the winter but business, mostly flying to and from Norfolk International





*Air tourists watch the action and wait their turn (right). For booth operator Sissy Johnson, waiting on a customer (below, right), and pilot Chuck Turner (bottom), ready for takeoff, the pace is speedier: The record for the summer is set on July 5, when Aero Tours makes 101 flights.*

Airport in Virginia, was slow. "Most of the winter I was in the hangar, scraping paint off airplanes. Actually, I learned quite a bit. I'm now a rather accomplished plumber; I can lay a wood floor, sand it, stain it, polyurethane it." When



there are no charters, Mankedick finds work for his pilots around the house as well as the hangar.

Turner got hired through sheer persistence. He called, he wrote, he visited, and the day after he got his flight instructor's certificate he turned up on Mankedick's doorstep with everything he owned packed in his truck, ready to work, and was settled in the Shed that night. "I found out later that worked for a couple of other people too," he says. He flew banners—"dragging rags"—up and down the beach all summer, then moved up to tours, flying 10 hours a day, and added charters. "I came down here to build up time, and I'm not afraid of hard work or long hours. I'll do whatever it takes to get a job." Turner shows off the poster of the 747 cockpit tacked up in his windowless cubbyhole in the Shed. "That's where I'm going," he says.

At 10 a.m. on a weekday morning, Sissy Johnson opens the booth for business. She unlocks the door, hangs the American flag, gets out the cash drawer and the credit card reader, and starts selling flights to people waiting on benches in the shade. "You are about to embark on one of the most breathtakingly beautiful aerial tours imaginable," reads the Aero Tours brochure, "and you are doing it from the site of man's First Pow-

ered flight, the Wright Brothers' monument... After covering close to fifty miles you will land back at First Flight Airstrip where your pilot will complete and sign your First Flight Certificate." The summer will see a steady stream of First Flight Certificate applicants, tourists who spend \$20 for a new perspective on the fragile thread of the barrier reef and maybe a glimpse of schools of dolphins and two or three shipwrecks out of the hundreds that dot the shore.

Mankedick pops up in his 1952 Dodge



with his dog Squeaker and the day's supply of ice water. "The record for tours is 167 flights in one day, back in the glory days," he says. "But the beach has changed, economy's changed, money's tight. Today, if we get 100 flights, we celebrate. And by the third week in August, these young guys don't even want to see the inside of an airplane." He explains the origin of the "Tucson rule," which dictates that pilots can fly tours for only two years: "Tucson's fourth year, he assured me that he and his wife were happy, he was good to fly around the lighthouse for another year. By the 10th of July he and his philosophies had all crumbled." "You just burn out," says Turner. To keep up morale, Mankedick throws several parties throughout the summer. "I used to have them at Awful Arthur's," a seafood restaurant whose T-shirts turn up all over the east coast, "but I'd end up with a \$2,000 tab. I mean, pilots were ordering filet mignon and feeding it to the piranhas in the tank." Now the Labor Day party is held at Mankedick's house, with a whole roast pig "and all the Busch Light you can drink," says Turner.

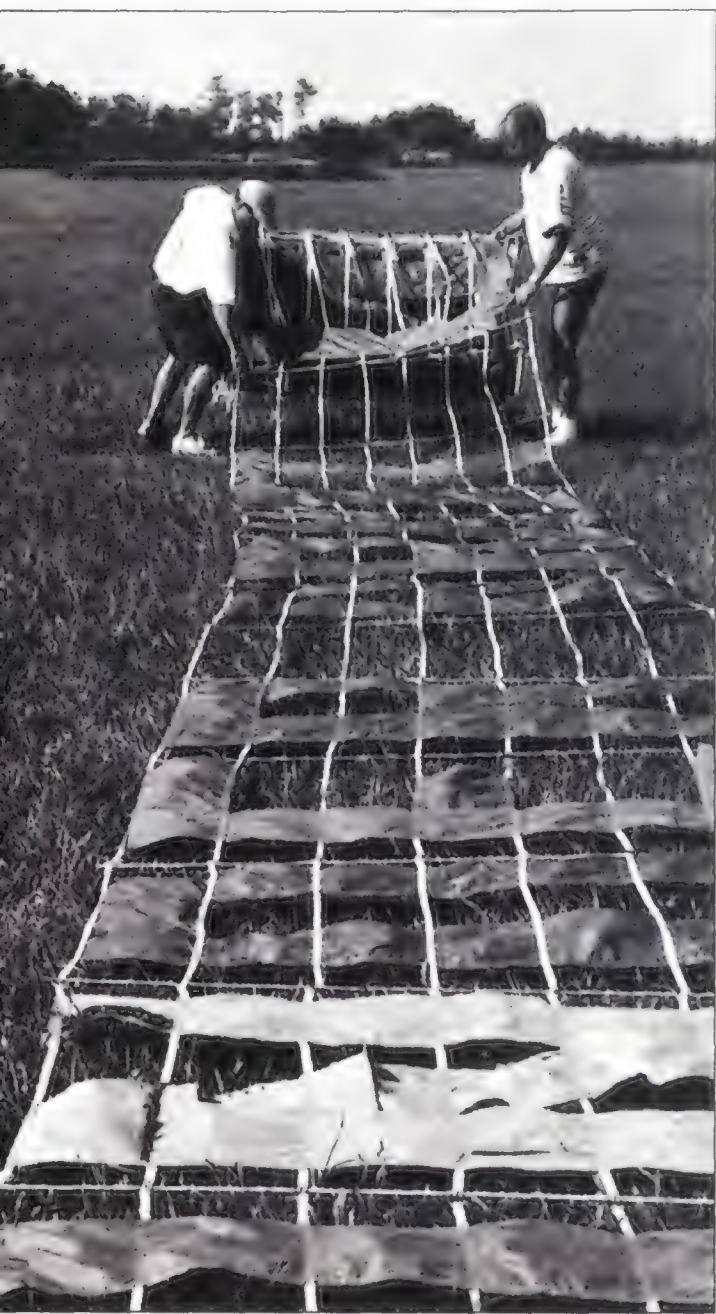
The 172s trickle in, with Johnson calling the hangar for reinforcements when customers start piling up. A Cessna 207 is usually on hand to take up a group of six, and at around 11 the main attraction will arrive, a 1941 Waco UPF-7 open-cockpit biplane. Scott Challice sells 15-minute rides in the front cockpit for \$90 to the more adventurous tourists. ("Biplane Scott makes killer tips," says Johnson.) Challice,



blond and weathered at 35, is not interested in logging hours; he more or less stopped counting at 8,000. He flies for the love of it, spending the summer with Aero Tours and migrating to Marco Island in Florida for the winter. "By the time I'm bored I'm out of here," he says, but, reflecting on the living he makes in giving rides, "I'm still going in circles wherever I go."

Over at the hangar, Turner describes the morning drill at the Shed: "One guy's shaving, one guy's showering, someone else is in the background brushing their teeth. As soon as one moves out someone else moves in. We've got it down to six guys in and out in less than 45 minutes. It's a pretty good assembly line."

*Turner helps new guy Jon Riebau (below, right) lay out a banner. New guys build time by "dragging rags" their first season. Biplane Scott (right, with camera) doesn't even keep track of his time. With some 8,000 hours, he flies just for the love of it.*



The Waco sits in the center of the hangar, a pan under its broad chest to catch oil leaks. A gutted 172 undergoing a 100-hour inspection sits in the back, its tail on a crate. Robert Ossman sits on an overturned bucket, painstakingly scraping peeling paint off the corrugations on the Cessna's horizontal stabilizer, until he gets called to tour duty. Nearby, Greg Wartes is immersed in an engine overhaul. A gourmet cook, Ironsides rifle champion, and airframe-and-powerplant mechanic, Wartes is charged with maintaining the aircraft. "Dadgum salt just raises hell with radios," he says. "With everything." Elbow-deep in wrenches and pistons, he issues a general warning: "I need to be pretty focused." In other words, pilots should not bother him with little gripes about the airplanes today.

Eric Dreelin is laying out the day's banners—The Lost Colony, Carolinian, Big Daddy's, Ocean Atlantic. This is Dreelin's first year, and first-year guys start with banners. "Doing pickups are great," he says. "The only thing is you're out there by yourself all day. But what better place to pay your dues than in the Outer Banks?" Mankedick pops in and out, telling Turner he's got a 3:30 charter and sending Ossman and Andrew O'Brien to the Booth. "This company's my whole life," says O'Brien. "It's like summer camp. No—I wish summer camp had been this cool."

Tracy Johnson, a former flight attendant for United, drives to the booth to check if she might fly today. The back seat of her car is full of Aero Tours brochures and holders, which she will distribute to restaurants and hotels all over the Outer Banks. Johnson lived in the Shed last year with a full house of 10 but bailed out for less chaotic quarters. She is still catching flak for hanging a puffy pink sponge in the shower.

Darwin Ford turns up, fresh from a four-hour patrol checking on collared wolves. "The ladies love Darwin," says Sissy Johnson. "He's our ladies' man. It's that smile." From behind dark glasses, Darwin flashes his trademark. "Oooh, he's good-looking," croon two customers. "We'll fly with him." Along with wolf flights for the Park Service, Aero Tours conducts a "Wright Stuff" informal lecture at the museum and a "Cleared for Takeoff" mini-seminar, taxiing an air-

plane over and inviting kids to play with the controls. Turner's just learned he's standing in for a more experienced lecturer this morning and has stage fright.

By noon the 172s have fallen into a steady rhythm of takeoffs and landings, occasionally darting off to the hangar to refuel. The pilots, poised and confident, engage their passengers with small talk. Turner, whose baby face belies his age of 25, says, "I try to break the ice walking out to the airplane by saying, 'Next week I'm going to graduate from high school, then get my driver's license.'" After each flight pilots



escort their charges back to the booth, pose for pictures, issue certificates and wing pins for the kids, and sometimes get tipped. Mankedick makes a run to the mini-mart and returns with 10 chili dogs. The more fastidious pilots give them a wide berth; Biplane Scott wolfs down two with a Coke chaser.

Ossman is wearing a big smile today: it's his first full day in the big 207. "You come up through 152s, 172s," Mankedick explains, "then one day you're in a 207 and you look back and see these six shining faces." An honest-to-God load of passengers.

Between flights, pilots fold brochure holders into shape, clean aircraft windows with Pledge, and talk about flying. They're at a Catch-22 in their careers. Many are closing in on the 1,500 hours they need to get their Airline Transport rating, but to get a job, they need time in advanced aircraft, and no one will hire them without it. "The big block is that 500 hours multi," says Ossman, referring to the multi-engine experience required to land a good job. "It's easy to log single time but multi is harder to find." They beg and borrow and accrue in dribs and drabs: Ford has



been washing and waxing a twin-engine Piper Navajo in exchange for a couple of hours.

For people living in a beach town, no one logs much beach time. "All your friends are working. There's no one to go to the beach with," says Turner. "On my day off I end up calling Jay and saying, 'What's going on?' Jay says, 'Didja have any beer yet? Don't drink any beer,' in case there's a pop-up charter. I guess he thinks in our spare time we open our eyes at 6 a.m. and start drinking beer."

Two flights of four F-15s circle the monument at a respectable altitude. The flyboys from nearby Navy and Air Force bases use the airport, monument, and even the 172s as targets. Pilots say it is not uncommon to be sailing along pointing out the Bodie Island lighthouse to your passengers and find an F-14 on your tail with gear and flaps down trying to sneak up on you. Or you'll look up and find an F-18 or -15 making a pass at your windshield. "An F-14 comes head-on, knife edge," says Ford. "I just rock my wings—best I could do."

As if on cue, an ominous whine is heard from the north, below the tree line, and an A-10 Warthog tears down like a hawk diving on a rabbit. Then another, 300 feet tops, and another, four in all, executing a snappy right break over the taxiway and scaring the tourists. Mankedick, pulling away in the Dodge, leans out and shouts to Sissy Johnson,



"When the calls start coming in, we don't know *anything* about it."

Late in the afternoon, when there are no customers and no Mankedick in sight, Ossman demonstrates Chair Luge: Position yourself in the office chair on rollers at the top of the ramp, assume as much of a luge position as possible, push off, and hope to gain enough momentum to make it down the ramp and roll out onto the pavement.

Tacked to a bulletin board in the booth is a snapshot of another diversion. The photographer captured a final approach that gained him membership in the First Taxiway Club, which comprises those who set up a minimum-speed approach to Runway 2 with full

*Dog days: While Squeaker waits in the roadster, Aero Tours owner Jay Mankedick (below, left) drops off a litter of hot dogs for Andrew O'Brien and other hungry pilots. Lunch, when there is lunch, is on the run: There's always a plane-ful of tourists waiting (above).*

flaps and lots of throttle and make the first turnoff, some 300 feet down the runway. Management does not endorse the practice.

Around 6 p.m. deer come out to feed in the grass on either side of the runway and regard the aircraft with mild curiosity. At dusk, Sissy Johnson takes down the flag, locks up the booth, and hikes up

the steep hill to the monument to tell visitors the park is closing. Today was a so-so day: nine Waco flights, fourteen 207 flights, and twenty-eight 172 flights.

That evening everyone meets at Dare Devil's for pizza and beer. Tracy Johnson and Biplane Scott are excitedly discussing the New Year's bash that the fabulously wealthy and airplane-obsessed Kermit Weeks is planning at his new museum in Florida. "It's a black-tie ball," says Johnson, "or period costumes. Isn't that *great*?"

Talk turns to the concept of pay-for-training, which is gaining popularity among employers at a time when pilot wannabes vastly outnumber pilot slots. Rather than following the traditional practice of getting hired by a regional airline and trained in its aircraft, pilots pay for the privilege of flying as copilot, logging that much-needed time but paying for the training that used to be free. "People who have money can do this and people who don't, can't," says Turner. "They're busting their butt to get ahead and are losing out. It comes







Besides flying air tours, pilots take on jobs like delivering mini-lectures at the Wright Brothers museum next door, here led by O'Brien (above). They also help mechanic Greg Wartes (below) maintain the fleet. The airplanes' chief enemy is the environment: "Dadgum salt raises hell with everything," Wartes observes.

to the point where if you want a job with a commuter airline, you go to Flight Safety," a training facility in Florida. "They send your résumé out. Once you accept a job you pay Flight Safety \$10,000, learn how to fly the airplane, and now you have a \$15,000 job that you paid \$10,000 for. You didn't make a whole lot of money off that deal. Then again, it is kind of a jump start on your career."

At nine the next morning three tours are waiting and there's only one pilot on hand. When Mankedick arrives, he slaps a wooden "9" over the "10" in the "Open at 10" sign. Summer has officially begun.

Ten weeks later, Mankedick reports that business has been down 20 percent from last year. "We lost two pilots: one love affair gone bad, one new job offer," he says. "Right now, the guys are preoccupied with job opportunities, falling in love, falling out of love." Tracy Johnson has left town after a relationship with Biplane Scott went sour, and Mankedick has decreed that "no one falls in love the rest of the summer." Darwin Ford and his smile left to fly Grand Canyon tours in single- and twin-engine Cessnas.

Part of the drop in business was due to twin hurricanes: Bertha, who blew through in mid-July with 100-mph winds, and Fran, who arrived on Labor Day weekend. "We caught up

on sleep, drank a lot of beer, and sat on the porch," says Ossman. "We had some time off." They managed to cram all 10 airplanes, various lawnmowers, and Greg Wartes' car into the hangar before the worst of Bertha hit. July 5 was the summer's record: 101 flights.

Turner got to log some twin-engine time: "I met a guy who had to fly his Cessna 310 back to New York, and I told him if he let me fly the plane back with him I'd buy the gas. I washed and waxed it, flew it back to New York, then got a train home." When the 310 owner came back down to fly the Waco for Challice, who needed a little time off, Turner negotiated a week in the 310. "I got 25 hours total between flying it back to New York twice and flying him around. I was paying for all the gas so he didn't care. Now I have almost 50 hours of multi time." He also logged a little social time and is smitten with a young woman who works at the legendary Old Rhinebeck Aerodrome. "She flies *taildraggers*," he says proudly.

Biplane Scott is subdued, still smarting from an encounter with First Flight's wildlife. He swerved to avoid a deer on the runway. The brake cable let go and the airplane went into a ground loop, which beat up the right wing.

Jon Riebau is a new hire, a reserved man who got a late start on a flying career. At 35, he is some 10 years older than most Aero Tours pilots, and differs also in that he is not remotely interested in an airline job. Riebau spent 10 years in Alaska and wants to return as a bush pilot. Mankedick hired him on the spot when Riebau, in a textbook example of being in the right place at the right time, stopped by the Booth to ask about a job. With 640 hours, he plans to winter over and make it an even 1,000. "In the two months I've been here, for the 140 hours I logged, I would have had to pay \$6,000 just for renting

a C-172," he says. "This is Mecca." But even pilgrims wane in the pursuit of their passion. "You do 14 tours a day in seven or eight hours, you start bumping into yourself," he says. Riebau lives in a camper on the lawn in front of the Shed—no AC, no water, no toilet. But he has his privacy. "I'm an Alaskan," he reminds you.

Brandon Bent is the other new hire, an outgoing and highly confident young man who announces: "By 2000 I should be flying for United." Bent has been banned from Wright Stuff lectures at the museum: fancying himself a stand-up comic, he ad-libbed most of his presentation ("The Wrights didn't bring their wives, since they were hoping to find mermaids..."). The Park Service was not amused.

There's an impromptu party at the Shed that night, with music courtesy of the Skyco Strangers, a local band (very local, like next door). "They're called Strangers because when they play, they sound like they've never met," says Turner. Pilots not on duty today have been wielding brooms and dust rags and stuffing the Shed's flotsam and jetsam into closets. At 9 p.m. the band is tuning up and a tray of potato chips is set out on the counter. The Skyco Strangers are indeed awful, but the beer is cold and the mosquitoes are not too bad tonight. The neighbors show up, along with a few townies, but attendance is sparse. Outside, Riebau stands in the yard, nursing a beer and gazing at the Milky Way, a broad ribbon in the clear black sky.

At 8:30 a.m. on the day after Labor Day, Mankedick is on the phone in the hangar ordering a 125-pound pig for the end-of-season party. It wasn't Aero Tours' best summer, but it wasn't the worst. Besides, he says, "on Labor Day, whether you've had a good summer or bad, there's an air of celebration. Everyone's glad to get their beach back, get their town back."

Dreelin is now ready to graduate to tours; Riebau, the new guy, will take over banners. The two are wrapping up banners that won't fly until next summer. "The Flat Flounders letters look real rough," says Riebau, fingering the shredded nylon. "Yeah, but from the beach they







look killer," says Dreelin. They decide to replace bad letters before storing the banners, and deftly unsnap the many fasteners. A well-worn copy of a popular pilot's newspaper lies on a scarred couch. "That's where we sit around and read *Trade-A-Plane* and dream about the jobs we're going to get and the planes we're going to fly," says Riebau. The biggest ad in the Help Wanted section is for Flight Safety's pay-for-training program.

After the pig-pickin' party, most of the pilots will scatter, aviation's nomads in search of multi time. "It's time to move on," says Jody McGee, the most senior in the Aero Tours hierarchy with three years of tours and charters and 1,400 hours. "He has to grow up and leave," is how Mankedick puts it. But the door is always open. "Once they've flown for us they can stay in the Shed as long as they want," he says. "We'll try to keep them in beer money."

"Ninety-five percent say their summer here was the best flying they've ever done," Mankedick says. "Monitoring a big machine through the air via computers isn't flying." But, he concedes, "it pays a whole lot better."

O'Brien logged 400 of his 900 hours this summer, and will be flying corporate jet charters in Green Bay, Wisconsin. Mark Pfister, who logged half



*For Kitty Hawk tourists, life's a beach, and then you fly. Chuck Turner's passengers (top) make sure they have something to show the folks back home; after a flight, Brandon Bent fills out a "First Flight" certificate for his happy customers.*

of his 1,000 hours this summer, may go to Atlanta for multi work. Bent, who logged 300 hours during his brief stay, is going back to school to study aviation science. Dreelin, who logged 320 hours flying banners for a total of 750, will winter over with Riebau, who will move into the Shed when it gets too cold and maybe learn some carpentry skills when the flying slows down.

Turner, who now has 1,400 hours, maps out his career. "My plan of attack is flying here until October at the latest," he says. "Then maybe fly canceled

checks or light parts for two years, building up multi time, get some instrument time. Maybe I could meet up with a corporate who needs a first officer, stay with that company and upgrade to captain. It's who you talk to, like that 310. I couldn't come across an opportunity like that if I was renting. Five years from now I'd like to be flying for a commuter, then the airlines," or better yet, an air express outfit like Federal

Express or UPS, where "there are no price wars and they don't furlough that often."

Turner is not worried about the current glut of airline pilots-in-waiting, and industry predictions are on his side. "I think opportunities in aviation are going to start to open up," he says. "The pilots who came out of Vietnam are in the airlines now, all getting close to mandatory retirement. Not to mention there aren't that many people starting up their student pilot licenses. I think there will be a drought eventually."

*At summer's end, Chuck Turner, Mark Pfister, and Scott Challice headed to Marco Island, Florida, where Turner and Pfister started logging multi-engine time flying charters to Key West in a Cessna 310. Biplane Scott spent the winter going in circles, giving Waco rides and making killer tips. —*



# Spacesuit Saga: A Story in Many Parts

Where do you get a suit of clothes that has to function as a uniform, an office, a bathroom, a spacecraft, an air conditioner...?

by Frank Kuznik

*Photographs by  
Breton Littlehales  
and by  
David Nance*

*The gloves of a spacesuit are so intricately constructed that they seem more complex than the hands they protect. Opposite: gloves are pressurized to test for leaks.*

## I. A Trip Down Moonwalker Road

On the back roads of central Delaware, it's all mushroom farms and chicken trucks until you pick up Carpenter Bridge Road, a two-lane blacktop out of Harrington. Within minutes a faded blue water tower appears on the horizon, and then a sign reading "Moonwalker Road."

You've reached the entrance to ILC Dover. The inside of the nondescript building is as low-tech as the neighborhood: plenty of worn carpeting and 1950s-style wall paneling. It is hard to imagine that this is the company that manufactures the world's most sophisticated apparel: spacesuits.

## II. The World's Tiniest Spacecraft

Judging by the photos you see in newsmagazines, you'd think spacesuits seemed simple enough, like the puffy jumpsuit worn by the Michelin man. Actually, a spacesuit is made up of nearly

20,000 parts. It has to be that complex, explains Glenn Lutz, Johnson Space Center's deputy branch chief of extravehicular activity and spacesuits, because it's "a pressure vessel that has to provide oxygen, take care of waste, cool you down, warm you up—everything that a spacecraft does. Basically, that's what the suit is—a one-man spacecraft."

Before embarking on an extravehicular activity—one that requires leaving the temperature-controlled, pressurized spacecraft and venturing into open space—astronauts first put on a urine collection device (essentially a diaper) and a suit of long underwear. Next they don the LCG (Liquid Cooling and Ventilation Garment). A one-piece, zip-up body suit, the LCG has a chiffon lining and outer layer of nylon spandex, which is laced with about 300 feet of plastic tubing. Water from a backpack the astronaut wears is circulated through the tubing to provide cooling.

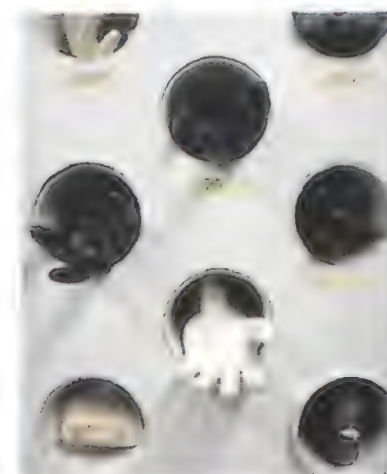








*The fiberglass Hard Upper Torso (shown with upper arms attached) is the portion of the suit most like a spacecraft: You don't put it on so much as insert yourself into it.*



Over this, the astronauts put on what NASA calls the Spacesuit Assembly: a bulky outer garment made of 12 interlocking pieces (excluding the helmet). The main piece is the HUT (Hard Upper Torso), a fiberglass shell that covers the shoulders and upper body and supports the backpack. The HUT is kept mounted on the inside wall of the spacecraft, and the astronaut puts it on by crouching underneath, lifting his arms, and raising himself up into it.

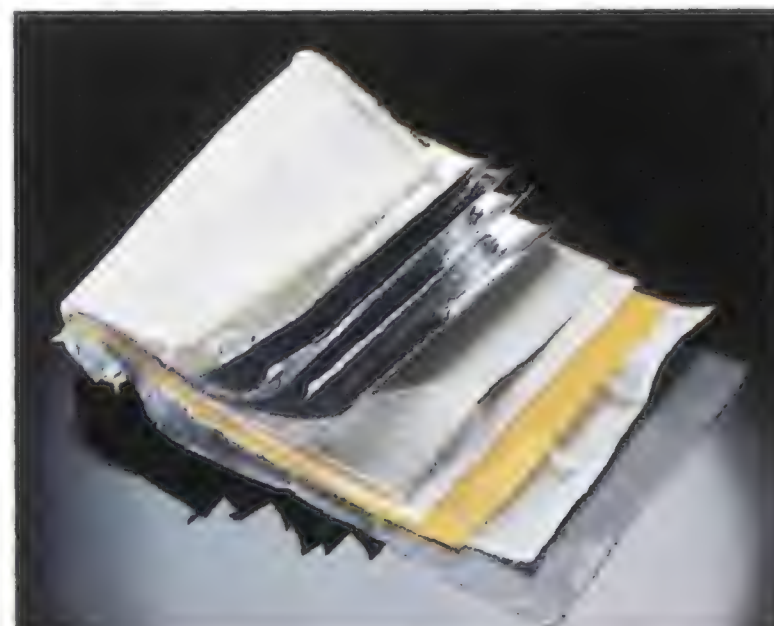
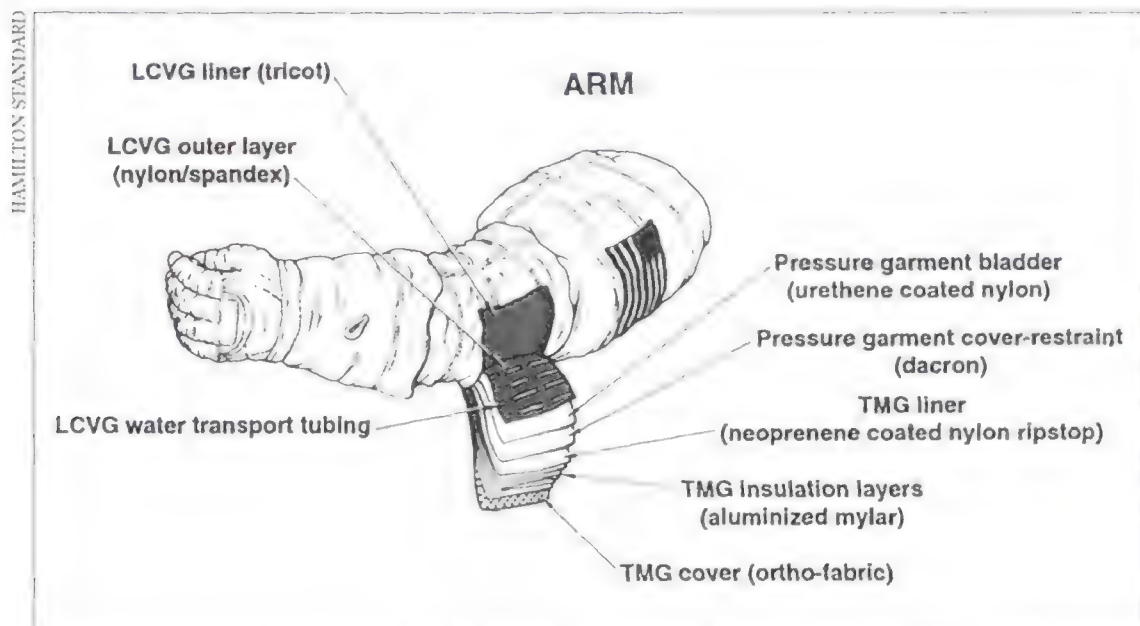
The remaining pieces of the suit are mostly fabric—pairs of upper arms, lower

arms, gloves, legs, and boots, plus a single waist piece that reaches to mid-thigh.

### III. The Layered Look

When an astronaut ventures into the vacuum of space, he must bring oxygen and his own pressurized atmosphere. Otherwise, he would die almost instantly from explosive decompression: Among other horrors, his lungs would rupture from the rapid expansion of the oxygen inside them.

*Depending on the position of the sun, the outside of an astronaut's suit can vary between -250 and 350°F. The spacesuit's layers of fabrics keep the interior of the suit a more livable 50 to 110°.*







Therefore, each fabric piece of the spacesuit is equipped with an innermost layer of urethane-coated nylon known as the bladder, which acts like a tubeless tire, holding oxygen inside. On top of the bladder is a very thin layer of Dacron cloth called the restraint, which helps keep the bladder from overexpanding in the vacuum of space.

Finally, there's the Thermal Micro Meteoroid Garment, which holds in heat and protects the wearer from space debris. The TMG is composed of neoprene-coated ripstop nylon, then five layers of reinforced Mylar, and finally an outer shell of Ortho-Fabric, a flame-retardant blend of Gore-tex, Nomex, and Kevlar—materials used by mountain climbers, parachutists, fire fighters, and others who need both flexibility and protection.

#### IV. The Most Gripping Part of the Story

By far the most complicated pieces to make are the gloves. "They have to be able to stop a bullet and pick up a dime," jokes ILC's spacesuit manager Phil Spampinato—which is only a slight exaggeration. Gloves do more work and take more abuse than any other part of the suit, demanding a seemingly impossible combination of durability and flexibility. Above all, gloves must fit well.

"I think the people who have had the worst experience in a spacesuit are those whose gloves didn't fit right—that can be very painful," says Jeff Hoffman, who was one of the astronauts who executed the first

repairs to the Hubble telescope.

In an astronaut's initial sizing, 22 different measurements are taken of each hand. If a proper fit cannot be found among the nine standard glove sizes, epoxy casts are made of his or her hands and sent to ILC, where a large rack of hand casts stands outside the "dip room"—a chamber made to withstand any explosion set off by the chemicals used inside. This is where technicians make glove bladders, dipping the casts into pots of polyether polyurethane and then drying them in rotisserie-style ovens. It is a weird sight: bright green disembodied hands spinning behind glass oven doors.

"Two pair, as you can see, are being made now," says Spampinato as he pauses in front of the doors. "Here's a monster hand, by the way. Whoever this is, he's got a huge thumb."

Before going up to the sewing room for a restraint, the glove bladders get flocking—a thin layer of cotton inside, which prevents them from sticking to the skin—and the wrist end is heat-sealed into a flange. The flange will be inserted into a metal ring; such rings are used throughout the suit as joints; they snap together so precisely that even a stray hair or eyelash can create a leak.

The glove's outer skin—its TMG—is



*Trina Thompson assembles gloves in the ILC sewing room. If an astronaut requires custom-fitted gloves, casts must be made of his hands (opposite, middle).*





stitched together from 13 pieces (finger backs, finger fronts, etc.) lined with nylon chiffon. To increase flexibility, the glove has only three layers of Mylar, instead of the usual five. Consequently gloves provide less warmth than the rest of the suit, but recently, suit engineers have added fingertip warmers—small foil heating elements with wires running back to an on/off tab at the wrist. The hand's outer covering is made of Teflon on the back and Nomex on the front, with silicone ridges trowled into the Nomex to enable the astronaut to get a good grip.

### V. Keeping Them in Stitches

Suit assembly at ILC begins with the arrival of metal parts and rolls of fabric, all inspected and tested throughout the manufacturing process. Fabric pieces are cut (and pieces of the nylon bladder are heat-sealed together), with flanges formed and reinforcements added where the pieces will be attached to connecting hardware. Areas

*Over the years, Ron Pippin has served as ILC's surrogate astronaut, struggling into and out of various suit parts to help technicians like Richard Bork (in blue jacket) evaluate fit and function.*

of heavy wear, such as the waist and upper arms, get an extra layer of polyurethane.

The fabric pieces are sewn in a long, brightly lit room. Depending on NASA's current needs, up to 26 seamstresses at a time may sit face to face across double rows of Singer 301 sewing machines. "We give them a sewing test when they first come in, so we know they have the ability," says spacesuit production manager Pat Donnelly, a personable middle-aged woman who has been at ILC for nearly 28 years. "But it takes a good three years before they can do the most difficult tasks on their own."

Sewing specifications are precise, especially for the small components. "Generally gloves are plus or minus 1/32 of an inch, and in some cases plus 1/32 and minus nothing," says Donnelly. "Say you have a seam allowance of 7/32, plus 1/32, minus nothing. That means your stitching has to be either 7/32 or 8/32 from the edge—and that's it." The better the fit, the less the wearer has to work against the layers of garment and the more efficiently he can work within them.

After the sewing room, the pieces go to Hard Goods Assembly, where they are sealed into the connecting rings. Then they are put through a final round of tests and a number of "cycles," or break-in exercises. To increase the components' range of movement, ILC assigns personnel to put on gloves and arms and legs and flex or bend them hundreds, even thousands of times.

From ILC, the suit components are shipped to Boeing Aerospace in Houston.







D.N. 63

*From ILC, suit components are shipped to Boeing Aerospace. Left: Robert Knight and Kay MacKenna assemble parts into suits; below, John Williams prepares to pressure-test a suit for leaks; bottom: Carletta Everett works on an air ventilation duct that is laced into the suit's undergarment.*

Boeing integrates the components into a full suit, then outfits each with a Portable Life Support System, a backpack manufactured by Hamilton Standard in Connecticut that provides communications, oxygen, temperature control, and other systems necessary to sustain life. The finished ensemble weighs about 295 pounds.

## VI. Suit Yourself

In the Apollo era, an astronaut would come to ILC for custom fitting and have three suits made: one for training, one for flight, and a backup. Today there are only 12 full suits serving NASA's hundred or so astronauts. Arms, legs, and other components are made in a variety of sizes, and at Boeing Aerospace, a mix-and-match custom-sizing is done for each astronaut.

At either end of the arms and legs, intricate metal devices hold "beams"—fabric strips—that can be shortened or elongated to make minor sizing adjustments. Boeing and ILC technicians make the suits more comfortable by adding shoulder pads, knee pads, rib pads, crotch pads, wristlets, moleskin between the fingers, and even a back pad nicknamed "Mattress Mac," after a well-known Houston television advertiser.

Some astronauts find that hours of careful sizing on the ground don't necessarily translate into a comfortable fit in orbit, where their bodies go through pronounced

anatomical changes. "We add a minimum of one inch to flightsuits because you grow in zero-G," says spacesuit coordinator Dick Button of Boeing Aerospace. "They're not completely sure what causes the growth, so it's hard to predict how much. Crew members report growth of anywhere from a quarter-inch up to three inches."

Even if the fit is accurate, movement in a suit isn't always easy. A suit may look flexible, but wearing one feels like being encased in a big plastic pipe. That's because the suit is pressurized. Normal atmospheric





*Boeing tests suits several ways. Right: Technicians hook a suit up to a panel that replicates the life support systems that in space are operated from the astronaut's backpack. Below: Astronaut Robert Curbeam is sealed in a suit for a test so realistic he will have to depend on the back-pack for oxygen and the radio to communicate.*



pressure on Earth is 14.7 pounds per square inch, but the spacesuit is pressurized to only 4.3 psi; that's enough to keep the wearer alive without making the suit so stiff it would feel as if it were made of iron.

Still, the suit is tough. A specific set of movements is required to do even the simplest maneuver, such as reaching across your chest with your right hand to flip a switch on your left side. "There are certain ways the suit wants to move, and very often a beginner will try to fight it," says astronaut Jeff Hoffman. "And you'll lose, because the suit is stronger than you are. You have to take things slow and steady."

## VII. Hanging Out Between Jobs

A new suit comes to Johnson Space Center with a usage life of eight years or 461 hours of manned pressurized time, whichever comes first. And even those numbers are more theoretical than real. "It's rare that a component sees more than 60 or 70 hours of actual flight time," says Dick Button. After that, a suit is downgraded to use in the water tank at Johnson that astronauts train in.

In between flights, suits are taken to the Boeing processing center for cleaning, inspection, and repair. The Ortho-Fabric is spot-cleaned with a mild soap and filtered water. The inside of each component is wiped down with a bactericidal solution, a routine the astronauts also perform after every extravehicular activity. Technicians wash the inner Liquid Cooling and Ventilation Garment with a solution of water and baking soda, which helps to remove odors.

Inspection is done in two stages. First, components are pressurized to 1.5 times



normal operating pressure and visually inspected. "We look for structural damage," says Button. "That's any deformation of the soft goods—seams starting to come apart, bulges where there shouldn't be bulges—any kind of abnormal stress change." Components are then deflated for at least 15 minutes before being pressurized again, this time to normal operating pressure, and tested for significant leaks.

Nothing can be made completely leakproof, of course, but technicians keep leakage below established levels; for an arm, the maximum allowable leak is 24 standard cubic centimeters per minute; for an entire suit, it's 99.3 scc per minute, a volume that, were it liquid, would fill a quart jar in seven minutes.

Leaks that exceed the thresholds are patched, as are tears and abrasions. The Ortho-Fabric is covered with a patch of the same material, sewn on, while patches to the bladder are bonded with a polyurethane adhesive.

But operational spacesuits rarely need routine repairs. "We haven't patched any flight gear in probably 10 years," says Button. One exception is the protective visor on the helmet. There are actually three layers on the front of the helmet: the pressure bubble, made of a clear polycarbonate material; a protective visor over that; and the familiar gold sunscreen visor, which the astronaut can roll down if sunlight is impairing his vision. When you're wearing a helmet, the natural tendency to move closer to your work often ends in a bang.

It's the suits used in the training tank that need constant repair. Training suit hardware is taken apart every 40 hours so that it can be lubricated and checked over for corrosion ("Aluminum and highly chlorinated water don't agree with each other," says Button). And helmet visors get scratched and banged up even more in the training tank than they do in space, because the trainees have to cope with diffraction caused by the water, plus the depth distortion caused by the visors.

For all that, spacesuits have proven to be amazingly durable. "We're just now wearing out some of the stuff we've been throwing in the water tank since '82 and '83," says Button. Even then, NASA will find a use for it. "When it's no longer prudent to use in the pool," says Johnson's Glenn Lutz, "we'll downgrade it for public appearance stuff and take it to schools."

## VIII. Like Wearing Nothing At All

When astronauts look back on their adventures, how do they regard the experience of wearing a spacesuit? Being locked into such a massive, awkward apparatus seems like it would leave a more vivid impression than the experience of being in space. Do the astronauts ever feel trapped in the suits? "We're all given claustrophobia tests before we're accepted into the program," Jeff Hoffman says, "so no, I don't feel claustrophobic. In fact, just the opposite. When you finally go outside the airlock, you've got this great wide-open cosmos in front of you. It's a wonderful feeling of freedom." —

*More than the sum of its parts: Kathryn Sullivan, the first American woman to walk in space, explains that a spacesuit "does not have all the same ranges of motion that your body has. Its shoulder is not like yours, and its knee is not built like yours, so you learn...a whole set of lessons that have to do with suddenly being a person of greater mass and volume."*



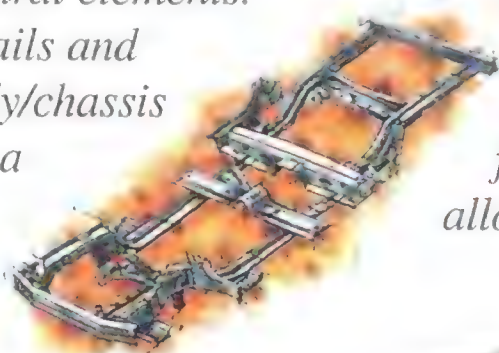


# Smart enough the sharper



*The sheer intelligence that makes Stratus an outstanding road car begins with supercomputer-designed structural elements.*

*Incorporating steel rails and crossmembers, Stratus' rigid body/chassis unit resists flexing and provides a solid base for its modified*



*double-wishbone suspension. Similar to race-car designs, the Stratus suspension achieves exacting control of wheel movement in cornering for optimum grip. Available speed-sensitive, variable-assist rack-and-pinion steering provides a reassuring feel of the road at high speed while allowing easy maneuverability at low speed.*





# gh to outwit est curves.

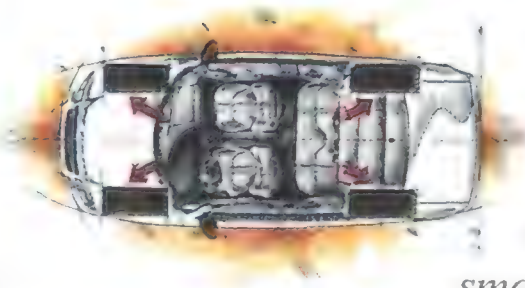
To the wisdom of all this, add the genius of cab-forward architecture. Cab-forward design moves the wheels toward the corners for increased stability, while allowing an



Dodge is the official vehicle of the Skip Barber Driving School.

expansive windshield and short, low hood for great visibility.

Of course Stratus, like



all cab-forward Dodge automobiles, provides lots of room inside for people. Very smart people.

To find out more about Stratus, call 1-800-4-A-DODGE or visit our Web site at <http://www.4adodge.com>



Stratus  The New Dodge



# X-1: An Inside Look

*Snapshots of a secret  
work in progress*

*Captions by Barry DiGregorio*

*Photographs from the collection  
of Carolyn Moore Baumet*





*The second of the three Bell X-1s, all of which were designed to be drop-launched, made one conventional takeoff. "Douglas and the Navy were building the D-558-2 and were running ads saying the X-1 was not a true supersonic plane because it had to be drop-launched," says Chuck Yeager. On January 5, 1949, Yeager fired the four rocket chambers simultaneously, "broke ground at about 1,200 feet, pulled the X-1 up into a steep angle, rolled out at 23,000 feet at Mach 1.1, and that was the end of that."*

The three first-generation X-1s built by Bell Aircraft were the first in a long line of experimental aircraft—X-planes—that have rocketed over California's Edwards Air Force Base (known as Muroc in the X-1s' heyday). As the first of many, the Bell X-1 had to take on the biggest challenge: conquering the "sound barrier."

While the X-1 program (originally "XS-1" for "experimental sonic") was classified, it wasn't nearly as secret as today's "black" programs, in which aircraft like the F-117 seem to materialize out of thin air. In fact, Air Force secrecy didn't really clamp down until after Chuck Yeager made his historic flight, reaching Mach 1.06 on October 14, 1947. *Aviation Week* ran a slim account of the achievement in its December 22 issue, but the Air Force did not officially announce it until the following June.

Before that milestone, however, pilots made many test flights and engineers did

a lot of fine-tuning of the airplanes' engines and fuel systems. Rocket propulsion engineer Wendell F. Moore was involved in the design of the X-1 fuel tank and plumbing from September 1946 to March 1947, and during that time he "always had a camera with him," says his daughter Carolyn Moore Baumet. Last year, when Baumet was turning over her father's awards to the Buffalo Museum of Science for an exhibit on the engineer, she discovered the photos he had taken of the X-1 project when it was in full swing. Moore went on to work on the X-1A, -B, and X-2 before turning his attention to the rocket belt, which he developed for Bell in 1961.

On a program like this, the true measure of your progress is how dirty your hands are at the end of the day. It's appropriate, then, that these snapshots have a gritty feel. More than that, there is a sense that something fantastic is under way.





*The nitrogen evaporator, with its 36-inch diameter sphere (below), converted nitrogen from a liquid to a gas, which pressurized the X-1's ethyl alcohol fuel. It also pressurized the cockpit, which meant X-1 pilots had to wear oxygen masks. Bell assistant chief engineer*

*Jack Strickler (with hat) and X-1 chief rocket engineer Bill Smith (center) discuss its workings. The X-1 often jettisoned its fuel in flight; here it jettisons liquid oxygen, the fuel oxidizer (bottom). Safety regulations were decidedly more casual than they are today.*







*For test drops, the X-1 was filled with distilled water to simulate a full fuel load, bringing its gross weight to 12,000 pounds. The B-29 carrier had its bomb bay doors removed and cuts made in its belly to accommodate the rocket plane (top). B-29 copilot Mark Heaney, in leather jacket,*

*strikes a pose near the nosewheel. After an unpowered flight to test the fuel jettison systems, frost from the liquid oxygen coats the X-1's underside (above). Pilot Chalmers Goodlin (center, in leather jacket) and Bell and Muroc personnel discuss the upcoming powered flight.*





*Bell X-1 chief rocket engineer Bill Smith (above, with hat) and a technician examine the X-1's interior. The bay above the wing housed flight research instrumentation. X-1 crew chief Charles "Mac" Hamilton (right, sitting) and Bell mechanic Frank Nicolas inspect fuel lines. The four chambers of the Reaction Motors XLR-11 rocket engine together produced 6,000 pounds of thrust. The engine had no throttle—it was either full on or off—but each chamber could be fired individually. Nicolas (opposite bottom, sitting at left) and Hamilton (sitting at right) inspect fuel lines with assistance from Smith. The "loading pit," where fuel, oxidizer, and gaseous nitrogen were pumped into the X-1, comprised the storage tank for liquid oxygen (above left wing), the liquid nitrogen tank (above right wing), and the nitrogen evaporator and sphere (at right). Goodlin made the first powered flight of the X-1 on December 9, 1946 (opposite, top). Upon reaching 15,000 feet with two chambers firing, Goodlin fired all four chambers momentarily "and experienced the true full power of the X-1's fantastic acceleration," he says.*







NAVIER







**I**t began with glacial waters: icy cold, sediment-filled, streaming down the Sierra Nevadas more than a million years ago to fill a valley in what today is southern California's Mojave Desert. Cycles of glacial melting and drought followed, depositing more sediment on the floor of the large lake in the valley, then baking it to a parched, flat sheet as the waters vanished. Eventually the area grew more arid and the lake's source retreated for good, leaving behind a dry lakebed, polished to a featureless smoothness by the winds that pushed a sparse sheet of annual rain and sediment back and forth across its surface. The result was an almost perfect natural aerodrome: a highly forgiving 44-square mile runway with excellent year-round flying weather.

The first humans to get a permanent foothold amid this desolation were, not surprisingly, aviators. The area entered military service in 1933 as a site for bombing and gunnery training and was designated Muroc Bombing and Gunnery Range in 1940. But its destiny was decisively redirected on October 1, 1942,

when the Bell XP-59A Airacomet, the United States' first jet-powered airplane, made its maiden flight there. Although the airplane proved too slow for combat, it demonstrated the usefulness of the new technology—and the usefulness of Muroc as a flight testing field.

Since then, hundreds of aircraft types have undergone flight testing at the base—renamed Edwards in 1949 to honor a fallen pilot, Captain Glen Edwards (see "The Edwards Diaries," June/July 1997)—including virtually every Air Force aircraft and a good number of Army and Navy craft. In the skies above Edwards, pilots first flew past Mach 1 (and 2, 3, 4, 5, and 6) and above 100,000, 200,000, and 300,000 feet. In the years following World War II, no other place on Earth has witnessed as many aerospace firsts as this piece of high desert.

No one has a finer appreciation for the place than the pilots who have made Edwards aviation's hallowed ground. Neil Armstrong, who was a test pilot at Edwards before making a name for himself in the Apollo program, noted that

the juxtaposition of ancient geology and modern technology at the base not only didn't clash but "curiously, seemed to fit." It was test pilot Milt Thompson, however, who saw a greater logic to it all. Edwards was, he once observed, "where God intended man to land rocket airplanes."

On the following pages, we provide an overview—literally—of Edwards Air Force Base, and offer a sampling of the historic flights, tragic failures, and general carousing that have, over the years, formed the legend of Edwards.

***Since it started as a flight test center in the 1940s, Edwards Air Force Base has witnessed a vast range of aerospace history. Clockwise, from above: the Grumman X-29 advanced technology demonstrator; the Lunar Landing Research Vehicle, piloted by Neil Armstrong; the multiple-record-setting X-15 after a hard landing; the wooden Muroc Maru bombing target; and test pilot Milt Thompson with his infamous water skis.***

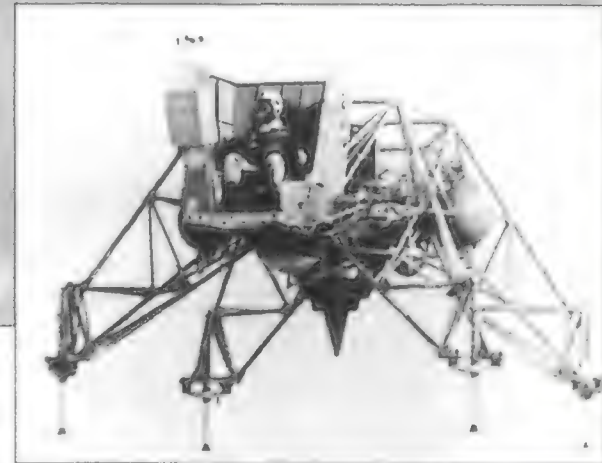


# X Marks the Spot

*And at Edwards Air Force Base, every spot tells a story.*



AFMTC HISTORY OFFICE



NASM



AFMTC HISTORY OFFICE



COURTESY PATRICIA TRENNER







*An aerial view of the north end of Rogers Dry Lake captures Edwards Air Force Base at an atypical moment: The dark areas on the lakebed are sheets of water, and clouds of dust fill the air. Wind rarely blows hard enough to kick up dust from the rock-hard lakebed, and rain at the 301,000-acre complex is also rare; the region of California high desert that encompasses Edwards averages more than 345 sunny days a year.*







✈ First Flight: North American YF-100A Super Sabre. World's first supersonic fighter at level flight, 5/25/53.

✈ First Flight: Northrop B-2 stealth bomber, 7/17/89.

Propulsion Directorate, USAF Phillips Laboratory (5 miles east). Est. as rocket propulsion laboratory in late 1940s. ✈

✈ First Flight: North American XP-86 Sabre. Prototype of dominant U.S. fighter in Korean war, 10/1/47.

✈ First Flight: Lockheed XF-104 Starfighter. Prototype of first Mach 2 fighter, 2/28/54.

✈ First Flight: Shuttle test vehicle *Enterprise* released from 747 to test glide capabilities; landed on dry lakebed, 8/12/77.

✈ Record Flight: X-15 attains 354,200 ft. (record still stands), 8/22/63.

✈ First Flight: Lockheed XP-80 Shooting Star. First U.S. operational jet fighter, 1/8/44.

✈ First Flight: X-24B Lifting Body. Last in a series of lifting bodies; yielded information used in development of space shuttle, 8/1/73.

✈ First Flight: Northrop XB-35 Flying Wing, 6/25/46.

✈ First Flight: Bell XP-59A Airacomet. First U.S. jet-powered airplane, 10/1/42.

Runway 23. Lakebed runway used for landing of first space shuttle, STS-1, *Columbia*, 4/14/81. ✈

✈ Crash: M2-F2 Lifting Body. Footage of crash used in opening sequence of TV show "Six Million Dollar Man," 5/10/67.

✈ Runway 18. Lakebed runway. Primary landing site of X-15 and lifting bodies.

North sled track. ✈ Used for rocket sled tests to study deceleration effects on humans, 1947-53.

✈ Muroc Flight Test Base; now North Base. Built 1942-45 for secret testing of early jets.

Compass Rose. Marked for general aircraft headings (not compass calibrations). ✈

✈ Crash (6 miles northwest): Northrop YB-49 Flying Wing. Base named after its pilot, Glen Edwards, 6/5/48.

✈ Jet Propulsion Laboratory Facility. Est. for rocket engine and propellant tests, 1945-95.





**X** Crash (40 miles east): Midair collision of North American XB-70A Valkyrie and Lockheed F-104 Starfighter, 6/8/66.

**X** First Flight: General Dynamics YF-16 lightweight fighter, 2/2/74.

**X** Record Flight: X-1 first exceeds Mach 1, 10/14/47.

**X** First Flight: Grumman X-29 advanced technology demonstrator, 12/14/84.

East camp (slightly southeast of here). **X**  
Original tent camp established in 1933 for bombing and gunnery practice.

Crash (2 miles south): Remotely piloted Boeing 720 crash-landed to test fuel additive intended to reduce post-impact fire, 12/1/84. **X**

Crash (four miles south): Bell X-1A. Became crippled while still attached to B-29 launch plane; dropped over bombing range, 8/8/55. **X**

First Flight (approx. 5 miles south): **X**  
The normally drop-launched X-1 makes a conventional takeoff, 1/5/49.

Crash (slightly southwest of here, on Runway 22): YF-22, prototype of F-22 Raptor, 4/25/92. **X**

Rogers Dry Lake.  
44 sq. miles, with more than 60 miles of marked and maintained runways.

Lakebed overrun for Runway 22/04. The 15,000-foot main concrete runway is just off the page. The most frequently used runway at Edwards, 22/04 is where hundreds of types of aircraft have landed, including the space shuttles and the X-24B lifting body.

*Muroc Maru* (6 miles south): 650-foot-long wooden model of Japanese heavy cruiser used for bombing and strafing practice in WWII; "sailed" here until 1950.

First Flight (at South Base): Lunar Landing Research Vehicle. Simulated flight in Apollo lunar module, 10/30/64. **X**

Muroc Army Air Field; now South Base (2 miles south). **X**  
Built in 1941; Northrop Flying Wings, B-2 tested here.

X-1 fueling and loading pit (2.5 miles south). **X**

Muroc Townsite. Est. in 1910 by Corum family (who gave it their name spelled backward). Demolished in 1952. **X**

South sled track (8 miles south). Used for high-speed tests of ejection seats, 1949-63. **X**

**X** X-15 static test stand for engine runs.

Main Base. **X**  
Built 1952-56.

**X** Crash: Test pilot Milt Thompson's intent to water-ski on flooded lakebed collided with disapproval of director of flight operations, winter 1964-65.

**X** NASA Hugh L. Dryden Flight Research Center. Est. by the National Advisory Committee for Aeronautics in 1946 for aeronautical research and flight testing. Given current name in 1976.

Pancho's Fly Inn and Happy Bottom Riding Club (7 miles southwest). Included bar, dance hall, motel, restaurant, stables, and airstrip, 1933-53. **X**

Crash (7 miles southwest): A horse Chuck Yeager was piloting collided with a fence at Pancho's. Yeager broke two ribs two days before his historic X-1 flight, 10/12/47. **X**

Juanita's Bar and Grill (20 miles southwest; no longer in business). The Society of Experimental Test Pilots formed here, 1955. **X**

Crash (10 miles southwest): Engine fire forced emergency landing of X-15; fuselage broke behind cockpit, 11/5/59. At Rosamond Dry Lake. Also part of Edwards AFB, with about 8 miles of runways. **X**



# Change of Command

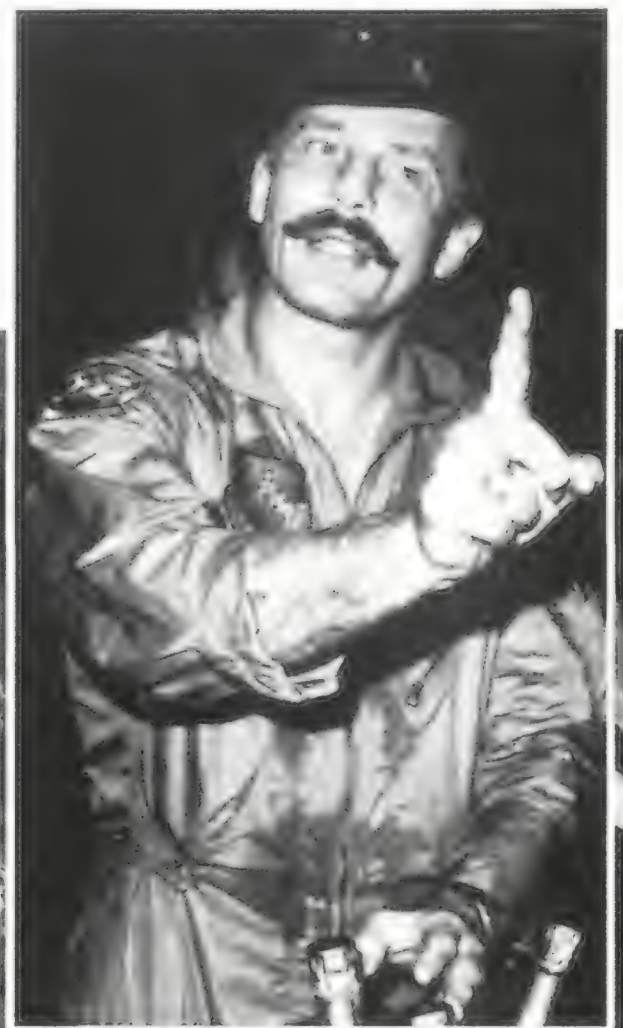
by Ralph F. Wetterhahn

Some pilots seem born for combat. They thrive on a steady dose of danger. Robin Olds was one of those. Olds was the commander of the U.S. Air Force 8th Tactical Fighter Wing during the second year of an air campaign called Rolling Thunder, the first sustained U.S. air assault on North Vietnam. I remember him as a disciplined, professional officer, but he was also a fierce fighter who bristled at, and frequently outmaneuvered, the political constraints that kept his wing from doing damage to the enemy.

Olds retired as a brigadier general in 1973. I visited him recently in Steam-

boat Springs, Colorado, where he's working on a book about his life and military career. I guess I wanted to reassure myself that he was real, not a hero we'd invented to rescue us from the cynicism of that war. I found a 75-year-old expert skier (and still hard drinker) who knew by name every ski instructor, ticket taker, waiter, and shop owner in Steamboat Springs and took the time to talk to every one, just as he had done with every member of the 8th wing 30 years before. On one ski run, a teenage snowboarder nearly creamed a little girl, and Olds went berserk. The snowboarder took off with that old

*Legendary for his leadership of the 8th Tactical Fighter Wing, World War II ace Robin Olds was an aggressive, precise flier. Destroying targets—like the two bridges in this reconnaissance photo—was the wing's job as he saw it, and he inspired the men in his command to get the job done.*





**Twenty pilots were down, our line crews were beat, and the Pentagon was jerking us around. Something had to change.**



dogfighter hot on his tail, going flat out. My memory of Robin Olds had been accurate after all.

I was a 24-year-old first lieutenant when I met him. I was with the 555th Fighter Squadron—the Triple Nickel—stationed at Ubon Royal Thai Air Force Base in Thailand, flying F-4C Phantom IIs on combat missions to North Vietnam. During the three months prior to Olds' arrival, the wing had lost an entire squadron's worth of airplanes. Twenty-two pilots were dead or missing. Getting to the magic number to finish a combat tour—100 missions over North

Vietnam—seemed impossible.

Rolling Thunder was begun in 1965 to break the communists' will and drive them to the bargaining table by destroying the factories and transportation systems that were supplying the Viet Cong in the South. The intensity of enemy resistance in the area around Hanoi called Route Package VI—which we shortened to "Pak Six"—made us pay dearly for that goal. And we weren't even sure we were succeeding. But in late 1966, we flew to Pak Six whenever the weather allowed. In September alone, U.S. air forces flew 12,000 sorties to the north. I remember Septem-

ber 20 in particular for so many reasons that have to do with living and dying: My second son was born, and the sky was clear over Hanoi.

We were already airborne and headed east when first light touched the South China Sea. After mid-air refueling, Captain "Bull" Fulkerson wheeled our flight of three toward the Vietnam coast and sandwiched us between two formations of F-105 Thunderchiefs. Our F-4s were more maneuverable and carried four AIM-7 Sparrow and four AIM-9 Sidewinder air-to-air missiles in addition to four 750-pound M-117 bombs. Our primary mission was to protect the





heavily loaded Thuds from any MiGs that might attack. If none came up, we would bomb a bridge near Hanoi.

The reason we had only three aircraft in our formation was that our unit didn't have enough flyable airplanes to send up the customary four. So my backseater—an affable Texan, Lieutenant Jerry Sharp—and I had no wingman. If we were bounced we'd be on our own, unprotected by another pilot detailed to spot surface-to-air missiles and keep enemy fighters off our tail.

Fulkerson spread the formation out. The sun was well above the horizon now, and light splashed across the green hills to the west. Fulkerson gave the command to arm our weapons—"Set 'em up hot"—and I immediately felt a pounding in my chest. I flipped the switches that turned on the missiles' systems and set the bomb fuzes and intervals. As we neared anti-aircraft artillery emplacements, Fulkerson ordered us to keep it moving. We started weaving left, then right, never flying in a straight line for more than five seconds so the gunners would have difficulty tracking us. We were doing 650 mph as we surged over the coastline north of the Red River delta.

Minutes after we crossed the coast, clusters of black puffs began to dot the sky. The 85-millimeter guns had opened up. One of the Thud pilots called out

that he had been hit. I saw the damaged plane ahead, clawing upward in a steep turn back toward the coast. Just then Sharp bellowed from the backseat, "SAM! SAM! SAM!" Off at our eleven o'clock a surface-to-air missile left its launch pad in an eruption of flame and smoke. I shoved the throttles all the way and felt my spine press deep into the seat back as the afterburners ignited and we pushed over to gain speed. Seconds later, the first stage of the SAM dropped away and the warhead stage arced over, coming down at us, then veering toward the stricken Thud above us. Over the radio I called to him to eject, but the SAM detonated right on top of his aircraft. Debris boiled out of the inferno.

I rolled into a dive. It looked clear between patches of exploding flak, so I made one adjustment and concentrated on the bombsight, setting the bright red pipper below a small bridge. At that point, any bridge was fine with me. At 4,000 feet, Sharp yelled "Pickle!" and I pressed the bomb button and felt a rumble as the four bombs kicked clear of the rack.

Radio chatter had become an insane jumble of overlapping transmissions. I



DICKSHULTZ COLLECTION ©

*Olds took time to check out equipment, including gear designed for getting down from trees. Pilots say this scrutiny helped them survive.*

*Able to carry stores for MiG patrol, flak suppression, and attack, F-4C Phantom IIs were the most versatile aircraft in the theater (opposite).*

*At morning briefings (below) pilots learned which of the F-4's missions they would fly that day.*

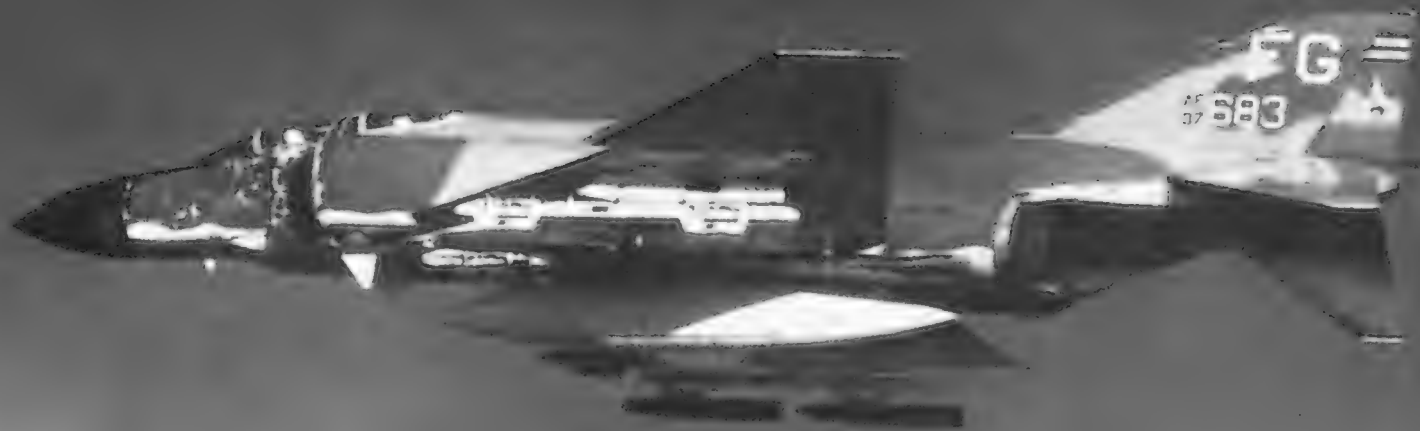
had lost sight of Fulkerson, so as I pulled the nose up through the horizon, I turned for the coast. A burst of flak rippled near my left wing. My knees were shaking so hard I took my feet off the rudder pedals and placed them flat on the floorboards. When I caught sight of Fulkerson, he was well out in front. Then I saw something closer, dead ahead—a white blur. I was doing 720 mph, but I swung left and barely missed the parachute. The F-105 pilot! He had survived flak and a SAM, and then I had nearly skewered him.

That's how it had been going, mission after mission. This one stands out because of the near-collision with a parachuting pilot, but the guns, SAMs, explosions, confusion, and airplanes being shot down were standard. Supported by China and the Soviet Union, North Vietnam had armed itself against the U.S. air attacks and by this time had 4,400 anti-aircraft guns and 25 SAM battalions in place.

The mission stands out for another reason. Once we reached the safety of







USAF VIA ROBERT F. DORR

the sea, Fulkerson's wingman, Fitz Fitzgerald, radioed that he was down to 900 pounds of fuel, barely enough in an F-4 to fly a hundred miles, which was just about the distance to the demilitarized zone. Fulkerson had him jettison his auxiliary tanks and head south. We watched fuel spray from the open tank fittings as they slowly tumbled seaward. The tanks hadn't fed; the valves had never opened. We had a pretty good idea why: It was the same reason that Sharp and I had headed north without a wingman.

Since the beginning of August the 8th wing had been directed by the Pentagon to "investigate the desirability of increasing sortie rates per aircraft." The same airplanes that flew day missions were to be reconfigured to fly missions at night, then switched back for daylight attacks the following morning. But switching aircraft back and forth entailed heavy work for maintenance crews. Daylight bombers carried a 370-gallon fuel tank on each wing, plus missiles and bombs. The night birds used a flare dispenser where a wing tank normally went and carried a centerline, 600-gallon fuel tank. Besides up- and down-loading tanks at sunup and sundown, the crews had to "refuel, rearm, and repair" aircraft that flew around the clock. The test program was called "Rapid Roger." According to wing records, between August 6, 1966, when Rapid Roger began, and September 22, the "operationally ready" rate for aircraft dropped from 73.8 to 54.3 percent. It's not that the maintenance crews weren't trying. The wing record also shows that extra men and spare parts authorized for the



### ***Fast Phantom***

The U.S. Air Force's premier fighter in Vietnam started out with the Navy. The Air Force gave the airplane dual controls so both the front- and backseater could fly it. Its twin General Electric J79 engines gave the F-4 enormous speed—1,500 mph—but also trailed smoke and made the first versions easy targets. Though the F-4 couldn't maneuver as well as the MiGs it flew against, its acceleration and avionics evened out the contest; piloting often decided it.

test were never delivered.

After midnight on September 13, an F-4C crashed just after takeoff. During daylight that same day, another crashed after an inflight fire, its cause undetermined. Of the 10 aircraft lost in combat since July, two were airplanes ordered North without wingmen. A MiG got one; a SAM the other. And now Fitzgerald: About 15 minutes after he dropped the useless external tanks—those same pesky tanks that were being disconnected and reconnected continually by overworked mechanics—he dead-sticked his airplane into a dirt strip at Dong Ha, just south of the DMZ. The F-4 went careening off the end, shedding missiles and landing gear. Both men climbed out unharmed.

"We were green beans," Dick Stultz said recently. Stultz was a Phantom backseater with the 555th, and he got to Ubon at about the same time I did.

I saw him at a reunion in April, and his memory of that time pretty much matches mine. "You may be trained to be a boxer," he said, "but you don't get in the ring with only the principles of fighting in your head, with no experience in winning and surviving."

Most of the pilots shot down over the past few months had been captains and lieutenants. We had noticed that the full colonels—the guys with experience—seldom flew to Pak Six. And some squadron commanders could find any number of reasons not to fly to Hanoi.

Those of us who were flying missions would get frags—fragmentation orders from the 7th Air Force headquarters in Saigon—the night before we were to go. They'd give you the target you were to hit, the time on target, and the tankers you'd get fuel from. You'd head over to the intelligence office and get every photo they had. Then you'd have all



# SEPTEMBER WAS THE LONGEST MONTH



DICK STULTZ COLLECTION

*Dick Stultz's scrapbook captures the mood at Ubon in late 1966. Stultz flew a dozen missions with Olds and says, "He came right atcha."*

*Opposite: The first to return from the Bolo sweep, Olds got cheers from the maintenance crews.*

quiet. And Olds gave the first version of what J.B. Stone, a captain with the outfit and its savviest tactician, came to call the colonel's "I'm-the-new-guy speech."

Stone, who retired this year from Continental Airlines, can recite the speech today. "He got everybody together and just laid down the rules," Stone says. "After he told us how it was going to be, he'd say, 'I'm the new guy. You know a lot that I don't know, and I'm here to learn from you. But in two or three weeks, I'm gonna be better than all of you. And when I know more about your job than you do, you're in trouble.'"

Over the next few weeks, Olds began flying combat missions with the 433rd. He had flown on the first Air Force jet aerobatic team and was a hell of a pilot. "He was pure business in the cockpit," Dick Stultz says. He continued giving the speech every now and then, always ending it with the challenge *I'm gonna be better than you*. He also visited the other squadrons and all the maintenance areas. He talked to us in the officers' club. Almost overnight, it seemed, he knew all our names.

"I kept running into Robin in Intelligence," says Stultz. "I was a real map nut. I had a background in geography so I wanted to know everything. And Robin would be in there in the late hours."

"The real dynamic was he started asking the same kind of questions we were asking," Stultz remembers. "He recognized that for the level of effort being expended the results were marginal. We had some issues—about how we were going in [to a target] in long strings. Everybody would go in at intervals, and as a result, every gunner would get the opportunity to shoot at every one of us."

Tactics slowly started to shift, and communication among wings and bases started to improve. Strike forces began to get over targets faster. Ron Miller,

night to think about it.

There were a lot of mornings when I'd wake up tense and sweating, listening to mosquitoes buzzing around in the dark. I'd kill a few and wonder if they could somehow warn each other about this guy that was splatting them. Then I'd stagger into the latrine. Four bare light bulbs hung above the sinks. Gnats were diving at the lights, and the sinks would be covered with thousands of dead bugs.

Two days after Fitzgerald slammed into the dirt at Dong Ha, Rapid Roger was put on hold. The 7th Air Force Commander in Saigon, General William W. Momyer, had seen enough bad reports from our wing commander, Colonel Joseph Wilson, and he suspended it. On September 30, Olds arrived.

We had heard about Olds. He had flown P-51 Mustangs and P-38 Lightnings over Europe in World War II and had scored 13 kills in dogfights. We'd also heard that he had been on the general's list some years ago, but had been redlined from promotion. We were curious to meet this resurrected bad boy, and soon after his arrival everybody got the opportunity. He ordered all pilots to come to the main briefing room—the first time we'd all been brought together.

I wouldn't have wanted to address that crowd. We had no respect for leaders because they weren't flying and couldn't talk to us about flying. And we had all the discipline (and about half the maturity) of the Los Angeles Dodgers in a dugout brawl. But the room was



who flew as Olds' backseater on several missions, remembers one highly coordinated strike of aircraft hitting the Thai Nguyen steel mill, northwest of Hanoi. "All 64 airplanes were on and off the target in two minutes," Miller says. "Our biggest worry was not being hit by flak but running into each other."

By November the wing's operational ready rate had increased nine percent and losses had dropped dramatically. Then General Momyer announced he was reinstituting the Rapid Roger test program. We could only assume that Secretary of Defense Robert McNamara's obsession with statistics was behind the move. The most infamous statistics, for which McNamara was later vilified, were body counts. In our case the statistics were sortie rates.

Olds protested, and he was overruled. But he made it clear to us that he didn't care much for statistics. He was after results. He stalked onto the stage of the briefing room one morning with a fistful of papers—decoration requests that flight leaders had filled out for his signature. He said there was a lot of interesting reading in the forms about flak, SAMs, and MiGs, but not very much about targets being destroyed. "Some of you want medals for just showing up," he said and dropped the stack of papers in a trash can.

I thought of Olds last April at a celebration of the Air Force's 50th anniversary. During a presentation on the Gulf war,

one speaker praised the "1,600 sorties and 455 missiles fired in the first 24 hours of Desert Storm." Not a single word about targets destroyed.

In one of his many lectures after finishing his tour in Vietnam, Olds said, "Our basic job over there is to bomb targets, not chase MiGs. If they happen to get in the way, so much the worse for them.... However, we liked [the MiGs] because they kept our morale up. All fighter pilots have a love for aerial battle. It's a great feeling to launch a missile at a MiG, even if the missile misses. At least you feel useful. After the mission you can tell terrible war stories about what a scrap you had."

Olds could tell stories about any number of missions; he flew 152, 105 of them over North Vietnam. But the one best known for a combination of MiGs and morale is Operation Bolo.

We planned it in a tiny storage room in the rear of the command center at Ubon. Captain J.B. Stone had been working there, assigned by Wilson to evaluate tactics. When Olds arrived, he directed Stone to put together a tactics manual for Southeast Asia. One of the constraints Stone faced was the U.S. policy that prevented us from attacking North Vietnamese airfields, which were in heavily populated areas around Hanoi and Haiphong. Olds decided we'd just have to get the MiGs in the air.

The idea behind Operation Bolo wasn't new: F-4s masquerade as the more vul-

nerable F-105s, then ambush the MiGs that come after them. The 45th Tactical Fighter Squadron at Ubon had gotten two MiGs in 1965 with a similar ruse. But Bolo was the first mission to disguise an entire strike force: 28 F-4s from the 8th; 28 from the 366th wing at Da Nang. We were to fly at the same altitude and speed as heavily loaded Thuds, and we were to carry the same QRC-160 radar-jamming pods the Thuds carried, so on North Vietnamese radars, that's exactly what we'd look like.

Olds sold it to Momyer and put Stone in charge of working out the details. Stone brought in Major J.D. Covington, Lieutenant Joe Hicks, and me to help him. It took us two weeks. Olds and Stone spent hours working on timing and routes alone.

Twelve flights would fly directly over the four air bases in and around Hanoi to draw the MiGs up; two flights would head northeast and block the escape route to China. We got six flights of F-105s from Korat and Takhli to attack SAM sites and free us to concentrate on the MiGs. We sent an EC-121 to orbit over the South China Sea to detect MiG launches and listen in on the enemy's communications with the ground.

We had tired of the jumbled code words issued in the daily frags from the 7th Air Force, nonsense like "Rolleye" and "Junetime," which might be friendly aircraft call signs one day and SAM warning codes the next. They were too difficult to use in the heat of battle. So





we named our flights after cars: Olds, Ford, Rambler. We named the F-105 flights on the Wild Weasel mission after weapons, such as Carbine. We coded the MiG bases by overlaying a map of the United States on one of North Vietnam and designated Phuc Yen air base in the northwest as Frisco, Gia Lam just south in Hanoi as L.A., and Cat Bi Airfield on the eastern border, Miami. Kep, in the middle, was Chicago. All a flight member need hear over the radio was either a call sign or a location and he would know exactly where the fight was taking place without having to refer to a cumbersome list of codes and translations.

We knew MiGs had only enough fuel for 45 minutes. We scheduled the sweep so that once the MiGs had been flushed out, for the next 55 minutes at least one flight of F-4s would be over each of the four enemy airfields, ready to shoot down MiGs as they tried to land.

Olds, ignoring Rapid Roger's push



TRUMAN SPANGRUD VIA ROBERT F. DORR

for sorties, stood the 8th down the last week in December and got ready. On January 2 we put the plan into action. Olds led and I flew on his wing.

Heavy clouds hung over Hanoi. We

couldn't see the airfields and SAMs could fire at us through the overcast, but Olds stayed cool. Every command and every maneuver was controlled. Meanwhile, our radars swept the area and showed the sky ominously empty. We had flown to a point north of Hanoi, then headed south toward the city; not until we reversed course at Hanoi to head north again did the MiGs come up.

Ford flight, led by Colonel Daniel "Chappie" James, arrived at about the same time that five MiGs appeared. In the January 13, 1967, issue of *Time* magazine, Olds described the ensuing dogfight as "a swirling battle that covered a huge part of the sky." We pulled and positioned and launched missiles for what seemed like hours, but the fight really lasted only nine minutes.

At the end of that time, Olds, Captain Walt Radeker, and I had each shot down a MiG. In a fight that took place just east of us, J.B. Stone got another.

Shortly after the operation, the 8th wing historian gathered everybody's thoughts on the mission. Airmen Second Class Donald H. Marquess from the intelligence staff remembered it this way: "It was during the waiting period while the pilots were gone that anticipation could be felt everywhere, from the dining facility to the barracks areas. Hours later, the first flight of birds made traditional victory passes—they were successful! After the first Phantom touched down and started down the taxiway to the ramp, the crowd which had gathered waited with anticipation as the first aircraft passed and Colonel Olds raised his hands and clasped them together. Cheers and clapping rose like nothing ever heard before. When the last plane touched down, there was a silence as figures were being compared, then a yell of 'all safe,' a gasp of air, and the thoughts and sounds of victory were all around."

*Above: Chappie James and First Lieutenant Mitch Cobeaga (dressed as "Phantom II") presided at the burial of Rapid Roger.*

*The wing helped Olds celebrate after his 100th mission to North Vietnam (inset). At Ubon, every red star up meant a MiG down.*



USAF VIA ROBERT F. DORR

ROBIN OLDS COLLECTION







*Mission accomplished: An F-4C on final approach at Ubon. The C and D versions of the fighter downed 86 MiGs in three years.*

*Olds left the Air Force Academy in 1971 (below). His decorations include the Air Force Cross, four Silver Stars, the Legion of Merit, the Distinguished Flying Cross, and the Air Medal with 39 clusters.*

Seven MiG-21s had been downed with no friendly losses, a single-mission record that stood throughout the war. We were decorated with Distinguished Flying Crosses, and Olds received his third Silver Star. He threw a huge party for the maintenance crews.

After that the parties seemed to go on continuously. Rapid Roger came to a halt at the end of January, and the wing marked the occasion with a wake, held on Groundhog Day, complete with a black casket. Some guys dug a grave outside the ops building and lowered the casket into it, and we all took turns urinating on it.

Olds began sporting a handlebar mustache, and he and his vice commander Chappie James, the first black officer to rise to four-star rank, got new nicknames: "Black Man and Robin." We also referred to Olds, who was all of 44, as "Old Man." We were still wise-asses, but we weren't screw-ups anymore. Olds had turned things around, and not a single member of that wing ever wanted to fail in his eyes.

On a typical evening at the officers' club bar, "Snoopy Versus the Red Baron" would be playing on the jukebox for the sixth time and half the place would be singing along. Olds would be knocking back scotch the way you empty a water glass. He might catch you out of the corner of his eye, and his eyes would lock onto yours so hard somebody'd get hurt if they walked between the two of you. After he had a few drinks, conversation with him was like toying with

a cobra. He could turn on the most innocent of comments.

The F-4D Phantom showed up in Ubon in May 1967. Equipped with a lead-computing sight, it was capable of using previously hard-to-aim 20-mm gun pods. It was also configured to carry the Hughes AIM-4D Falcon missile, which turned out to be a pilot's nightmare, instead of the Sidewinder. The Falcon required a complicated series of steps to cool the seeker head before the missile could be fired. Once the pilot started the cooling system, he had approximately one minute to fire the missile—an imprecision intolerable in dogfights, which, as Olds has said, "usually didn't permit the luxury of checking your watch." Olds flew one mission with the new airplane; he was unable to shoot down a MiG after three tries and came home hauling useless missiles. He ordered the entire fleet of D models rewired to use the old Sidewinders.

It was strictly against regulations. The modification required testing—the different armament could change the airplane's center of gravity, and a pylon had to be altered to attach the Sidewinder. But Olds issued a verbal order and told the maintenance chief that he'd take the heat. The maintenance teams, who by that time felt the same way about Olds that the pilots did, made the change. The rewiring for Sidewinders was eventually done Air Force-wide.

Olds shot down three more MiGs

that year—two during a vengeful chase after his wingman had been shot down. At the end of August he was placed on the general's list once more and reassigned as Commandant of Cadets at the U.S. Air Force Academy in Colorado. He got the promotion this time, and, while he was at the Academy, he went on the lecture circuit. He spoke, perhaps too candidly, about the way the war was being run, and a lot of us have wondered if he stopped at one star because he said exactly what he thought instead of what the Air Force wanted to hear. Olds has said he was dressed down more than once for remarks he made. He's the kind of hero who isn't very popular when his country is at peace but is desperately needed in wartime. I believe if called, Olds could pull it off again. I know a hundred old men who would follow him. →





# The Making of AIR FORCE ONE





Of course you realize nothing  
like this could ever happen.



by George C. Larson

Here's the concept: Some terrorists have a gripe with the United States. Terrorists are in the business of hijacking airliners, and as any terrorist worth his Semtex knows, there is one airliner without equal: Air Force One. And as long as you are going to hijack Air Force One, you may as well do it while the president and the first family are aboard.

In the action movie *Air Force One*, Harrison Ford is cast as the president of the United States and Glenn Close as the vice president, but the surprise star of this movie may well turn out to be an airplane: the Boeing 747-146 that plays the part of Air Force One, one of two modified 747-200s operated by the 89th Airlift Wing at Andrews Air Force Base in Maryland. To create a kind of stunt double for the presidential aircraft, the producers of *Air Force One* rented a standard production 747 from American International Airways, a charter cargo carrier based in Ypsilanti, Michigan, and founded by former drag-racing champion Conrad "Connie" Kalitta. The Boeing wide body, registered in the United States as N703CK, was the 54th built and the third to enter the Japan Air Lines fleet after it rolled off the production line in June 1970. All the other military aircraft in the film appear as themselves, with the services' costs paid for by Columbia Tristar Pictures.

The director of *Air Force One* is Wolfgang Petersen, whose film *Das Boot*, a gritty tale of life aboard a World War II German submarine, established his penchant for exhaustive research and painstaking accuracy.

To get everything right, Petersen relied on researcher Brian McNulty, who recruited experts from the Secret Service and the military. McNulty also

*The producers of Air Force One rented a 747 cargo carrier, added a new paint job and decals, and turned it into a presidential VC-25A lookalike.*





*Movies are hard enough on film crews when all the action takes place on the ground (above). Wolfgang Petersen and Michael Ballhaus (right) were further challenged by demanding aerial sequences. One featured a rescue attempt in which a commando is lowered from an MC-130 Combat Talon flying above the embattled and ersatz Air Force One (below).*

scheduled the military aircraft, a nail-biter of an experience: "I find it to be quite exciting when you order up a dozen aircraft, and your first day of shooting is on a certain day at 1500 hours, and I'm standing there on the tarmac, and at 1500 hours they start to roll in." McNulty acknowledges that

there's a price for such a high level of cooperation. The Air Force got script approval and the assurance of a positive depiction of the service and its people.

To obtain seamless realism in the flying scenes, which combine actual flying with shots of models as well as special effects created on computers, Petersen relied on McNulty's

experts and David Paris, the man responsible for the planning and coordination of every flying sequence. Paris, a helicopter pilot who learned his craft during eight years in the British Royal Navy, has an eclectic roster of motion pictures to his credit, from *Ishtar* to *Mission Impossible*.

Piloting the 747 was Paul Bishop, an AIA captain with more than 25,000 hours, 4,000 of them in 747s. The film involved two primary flying sequences, one shot near the Channel Islands off the California coast and another at Rickenbacker International Airport near Columbus, Ohio. In the latter sequence, Paris had to have the big Boeing veer off the runway, out of control, then take off and barely clear a parked C-141 transport. In the story, the crew members lock

themselves into the flight deck after hearing gunfire aboard. They plan to deviate to Ramstein Air Base in Germany, where special ground units can storm the airplane and overwhelm the terrorists.

While the AIA 747 was off getting a \$300,000 paint job to replicate the Air Force One color scheme, Paul Bishop was busy at meetings to map out how the sequence would be shot. "David [Paris] had a storyboard, like a comic book, where each scene is drawn out," Bishop recalls. To shoot the portion in which the 747 goes out of control and veers 45 degrees off the runway toward a near-collision, cameraman David Nowell planned to reduce the risk by using a time-honored trick and slow the camera down to half speed: 12 frames per second. "The sequence begins with us [stopped] on the runway, then we accelerate to pass camera center at 60 knots," Bishop says.



The film crew prepared for the shoot by using the aircraft performance manuals to calculate the acceleration and braking distances for the 747's weight and the air density at the airport to establish a maximum speed. Then Bishop assigned flight engineer Harvey Sigmon to observe the speed readout on the inertial navigation system while he and copilot Robert Earl "Jet Man" Jeter handled the power and the steering. When the final takes were projected at the normal 24 frames per second, the 60 knots looked





like a speedier 120.

Bishop repeated this and other action sequences through 10 takes and 60 hours on the 747's clock, which were stretched over many days by the limits of moviemaking and of the airplane itself. The landing at Ramstein is supposed to take place at night, but in order to get the light they wanted the camera crews could shoot only within a 15-minute window after sunset or before sunrise. And, like any star, the 747 had its own special needs. The 16 sets of brakes (only the nosewheels are not braked) have to be cooled down after each run. And it wouldn't have been moviemaking without the glitches: In one instance a "doghouse" sheltering a ground-level camera was blown over by the jet blast from the number two engine; the moviemakers rebuilt it and anchored it securely. Then early one morning, with a front moving in and ground traffic sending the crew on long detours around the taxiways of Rickensacker, they rolled the dice to perform a final take. And the gamble came up snake eyes.

"We 'thermalled' the tires," Bishop says, "and the boss was not happy with that." What happened was actually a built-in safeguard doing its job: To prevent explosive failure of the tires and rims from heat buildup, the braked

wheels on the 747 have metallic plugs that melt on overheating to release all the air in the tire. Even taxiing creates tire heat, and the 747-146 is limited to slightly less than seven miles on the roll before it has to stop and cool its wheels. Somehow, in the course of braking hard and taxiing back for another take, the tires had built up enough heat to melt the plugs. "It happened at 6 a.m., and by 6 p.m. it was ready [to fly again]," Bishop says, crediting his crew for the rapid turnaround.

The shoot planned for the area near California's Channel Islands involved a sequence wherein commandos extend a line from a Fulton Winch (see "Queasy Rider," Aug./Sept. 1996) mounted in an MC-130 Combat Talon to an entry hatch on Air Force One. The commandos are supposed to slide down the line to get aboard the airplane, then reverse the process to get off.

This time, weather was the problem. To establish that the airplanes are over the ocean during this sequence, the cameras needed a view of the water. "What we got was crud from 4,000 feet down to sea level," Bishop says. "And it was persistent. We were out there for almost two weeks...and we would take off every morning two hours before sunrise and look for a hole until the envelope for filming expired."

*A passenger who missed his connection? Pilot Paul Bishop extended the flaps so the 747 would match the MC-130's slower pace during filming of the commando sequence (above). Harrison Ford overpowers a terrorist in the cabin (below).*

Eventually, they got a break in the weather that enabled them to join up with the MC-130 and with the modified North American B-25 Mitchell camera plane. Flying at about 200 mph, well below the 747's speed when it is slowing to approach an airport, Bishop flew with the flaps extended 10 degrees throughout the sequence. The formation join-up involving three "dissimilar airplanes,"







*More than a mode of transportation, Air Force One projects the pomp and ceremony of presidential office, whether on film (above) or in real life, as it returns home to Andrews Air Force Base, Maryland, and the care of the 89th Airlift Wing (below).*

as Bishop understates the problem, was ticklish. The 747 cruises at more than 600 mph, C-130s are comfy at 350 mph, and on a good day, the B-25 can handle maybe 230, tops.

The MC-130 flew with a cable trailing behind it; the special effects wizards completed the linkup by connecting the cable end to the 747 with their computers. "They also add the people,"

coat comes off, and I'm hoping it doesn't enter our number two engine." They decided to ditch Felix.

Bishop had to fly in tight formation with the turboprop MC-130, responding to direction from the camera crew aboard the B-25. Using hand signals, they told him how they wanted him to adjust his position. Bishop established a visual reference somewhere on the MC-130, sometimes lining up a wingtip light with a spot on the smaller airplane's fuselage or lining up one of its antennas with a spot on his own windshield. Throughout this series, Bishop's cockpit was only a few feet away from the Talon's wingtip, and the other aircraft's tail was about the same distance from his number two engine on the 747's left

Bishop says, though there was one exception when the moviemakers tried to put a human figure on the cable. "They did trail a dummy—they called him Felix, dressed in a suit and tie, out of the Talon. But [the 747's] bow wave was moving him around, and first his tie comes off, and then his

wing. "I never thought I'd reach the age of 57 and have an experience like this," he says.

Although the 747 featured in *Air Force One* lacks the bulge in the nose for aerial refueling equipment and a few of the antennas found on the fuselage of the real Air Force One, the accuracy of its paint and studio-supplied decal markings fooled a lot of people on the ramp at Los Angeles International Airport, who believed the president was in town. The ensuing uproar was easy to allay compared to the excitement of the young fliers aboard a pair of F/A-18s who were scrambled to intercept some unexplained radar targets. "They came up and saw what looked like Air Force One full of bullet holes [simulated by decals]," Bishop recalls. "Once they ID'd it, [Los Angeles Center] told them who we were and they broke off and went home. But I can just imagine what was going through their minds," Bishop says, chuckling.

Whether real or replicated, Air Force One is more than just an airplane. "What attracted us to the project is the idea that Air Force One is the flying White House.... [As a symbol] it's as if the president is bringing the crown jewels," says McNulty. Air Force One has long embodied presidential prestige and global influence. Now, with Hollywood's help, add action-movie star power to that list. ✈







SMITHSONIAN  
STUDY TOURS

The Smithsonian

# Traveler

To request a catalog or brochure, please call (202) 357-4800. For all other information, please call (202) 357-4700; or write to The Smithsonian Associates, MRC 702, Washington, DC 20560.

Call or write for your FREE Smithsonian Study Tours catalogs, featuring more than 300 educational tours to 250 exciting destinations in the United States and abroad!

Smithsonian Study Tours offer unparalleled educational travel opportunities. Enjoy traveling with engaging study leaders and fellow Smithsonian Associates.



## INTERNATIONAL TOURS

**City Interludes** Throughout the year Extended stays in some of the world's great cities: London, Paris, Venice, Florence, Hong Kong, Kyoto, Vienna, Berlin, Prague, Istanbul, St. Petersburg, Krakow.

**Countryside Tours** Throughout the year Relaxing sojourns in France, England, Scotland, Wales, Austria, Switzerland, Italy, Hungary, the Czech Republic, Mexico.

**Christmas in Europe programs: Canterbury, Provence or Austria** December.

**Mexico by Land and Sea: Sea of Cortez and Copper Canyon** December 3-10.

**Vietnam by Sea, with Angkor (Cambodia)** Prelude December 7-20 Aboard the *Seabourn Spirit*.

**Christmas Family Safari in Kenya** December 21-January 2.

**Panama and the Panama Canal** December 30-January 7 Aboard the *Temptress Voyager*.

**Patagonia: Jewel of the Andes** January 11-24.

**South America Adventure and Cape Horn** January 14-27 Aboard the *Hanseatic*.

**Journey through Central America's Ruta Maya** January 16-27.

**Great Cities of Asia** January 18-February 1.

**Antarctica and the Falkland Islands** January 26-February 10 Aboard the *Hanseatic*.

**Belize's Barrier Reef** February 7-14 Aboard the *Temptress Voyager*.

**Mexico's Copper Canyon** February 13-21 and March 13-21.

**The Treasures of Thailand** February 13-23.

**Chile, Easter Island & Polynesia** February 15-28 Aboard the *Paul Gauguin*.

**Kenya & Tanzania Safari** February 15-March 3.

**Underwater Treasures of Bonaire** February 22-March 1.



## U.S. AND CANADA TOURS

**Smithsonian Anytime Weekend** (Washington, D.C.) Bring your family to see the Nation's Capital and enjoy the many free activities on the Mall. Package begins at \$107.50 per person for two nights, private Castle tour, and much more.

Special events you won't want to miss:  
**Amber: Window to the Past** - through Sept. 1.  
**The Jewel and the Rose: Art for Shah-Jahan** through February.

**NEW! Florida Manatees** November 8-12.

**NEW! New York Sampler** November 21-24.

**Yuletide in Brandywine Valley** (Delaware, Pennsylvania) December 5-7.

**Christmas in Williamsburg** (Virginia) December 11-15.

**Christmas in Savannah and Charleston** (Georgia, South Carolina) December 20-26.

**Christmas in Vermont** December 23-27.

**Christmas in Quebec City** (Canada) December 23-28.

**Virgin Islands Snorkeling** January 7-12.

**Everglades Wildlife** (Florida) January 10-16.

**Natural Florida: Caloosahatchee** January 31-February 8.

**Yellowstone in the Snow** (Montana) February 14-21.

**Caribbean Voyage: The Grenadines and Windward Leeward Islands** February 14-21. Aboard the *Yorktown Clipper*.



## SMITHSONIAN SEMINARS

Concentrated study of specific topics.

**Genius of Picasso** (Boston, MA) November 13-16.

**Epic Poetry** (Squaw Valley, CA) November 15-19.

**Treasures of the Federal City** (Washington, D.C.) December 5-10.

**God and Mankind** (Pacific Grove, CA) January 11-15.

**Behind the Scenes at the Metropolitan Opera** (New York) February 11-15.



## ODYSSEY TOURS

Moderately-priced tours with several departure dates in 1997.

**Sojourn in Greece: An All-Inclusive Stay in Vravra** 15-night tours in January and March.

**Discover Thailand, with a sojourn in Chiang Mai** 16-night tours in December, January, February and March.

**Gateway to India** 13-night tours in January and March.

**Natural Wonders of Costa Rica** 9-night tours in January, February and March.

For a Smithsonian Odyssey Tours brochure, call 1-800-932-8287.

Visit us online at: <http://www.si.edu/tsa/sst>

**A Sampling of Learning Adventures for Smithsonian Associates**





by William E. Burrows

**N**icholas L. Johnson, like many veterans, is proud of his war record and becomes unabashedly nostalgic when the subject comes up. But though he was in both the Air Force and the Navy and spent time in Vietnam, most of his memories are not of slogging through steamy jungles cradling an M-16 nor weathering salty squalls on the bridge of some heaving destroyer. Johnson made his major contribution to his country's national security in front of computer screens in California and Colorado. He was a soldier in the cold war, a "threat analyst" in a secretive fraternity of sleuths whose mission was to figure out what the Soviet Union was up to in space.

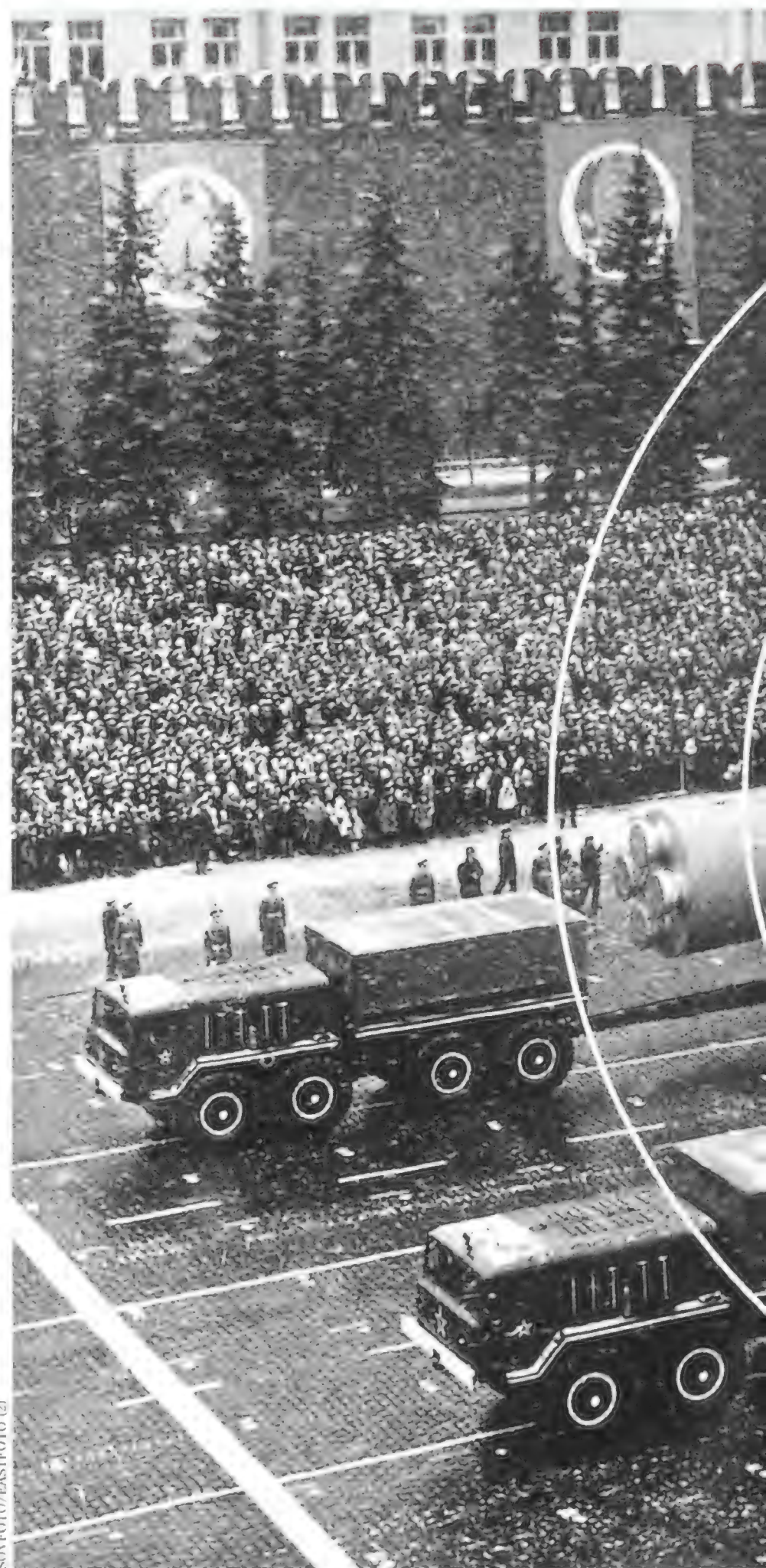
"My job was to find out what the bad guys had so we could knock it down," the native Tennessean says without emotion. "I think my experience in Vietnam helped. When you're around weapons that are meant to kill, it puts things in perspective.

"In those days," Johnson goes on, referring to his job as an analyst, "you were there to help protect your country. It was probably no different than it was for the guys who fought World War II. You wanted to go to work every day and do the very best job you could."

The reasons were compelling. They included identifying Soviet reconnaissance capability so the United States could keep its own secrets and protect its military in the event of conflict, determining whether the enemy could rain nuclear bombs on the West from orbit, verifying the latest Soviet claim to a space feat, and calculating how the Kremlin's "assets" could be "negated" by anti-satellite (ASAT) weapons—one of Johnson's specialties—in a space war.

*Soviet premier Nikita Krushchev brandishes photos recovered from Francis Gary Powers' U-2 spyplane (above). President Eisenhower halted the flights over the Soviet Union after Powers was shot down in 1960, but satellites were in place by that time. The Soviets sometimes assisted the surveillance effort by showing off weapons in national parades, as in this 1971 display of the SS-10 "Scrag" ICBM.*

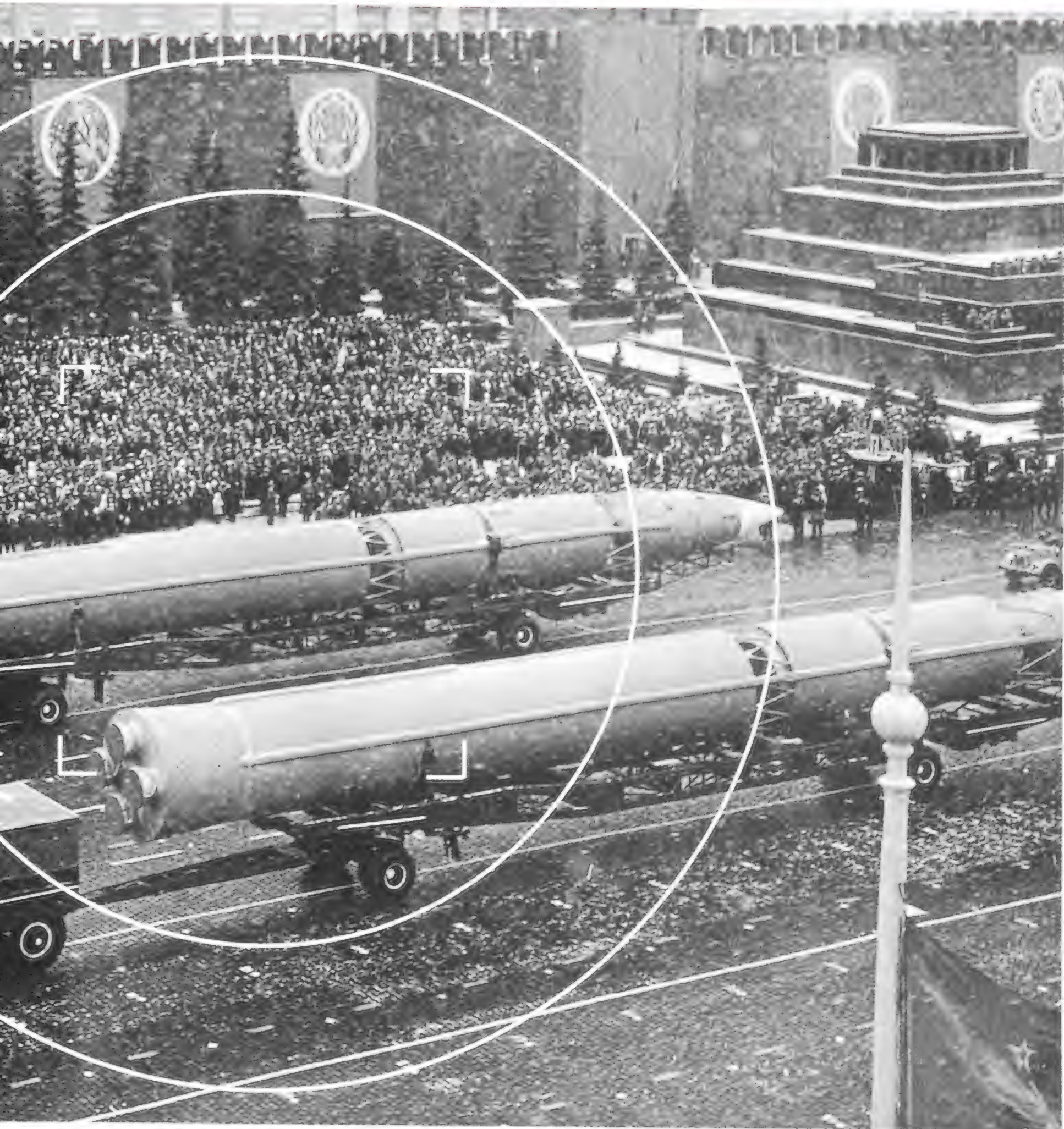
How the CIA assembled bits and pieces to complete a picture of the Soviet threat.



SONFOTO/EASTFOTO (2)



# STAKEOUT







UPI/CORBIS-BETTMANN

The Soviet ballistic missile and space programs, which were fundamentally inseparable because both depended upon the same huge rockets and were masterminded by the same scientists and engineers, were the targets of what was by far America's largest espionage operation, costing uncountable billions of dollars. It was justified by the fear of what the late Richard M. Bissell Jr., who directed the U-2 and early satellite reconnaissance programs for the Central Intelligence Agency, conceived of as an atomic Pearl Harbor—a devastating surprise attack in which the Soviets would use their arsenal of nuclear weapons, ballistic missiles, and potent space capabilities to leave the United States buried in radioactive rubble.

The cadre of highly skilled experts of which Johnson was a member worked in the military intelligence services, the CIA, and the National Security Agency, as well as for private contractors. They got their information from a colossal intelligence shell that had been erected over the USSR with tracking radars, signals-interception antennas, ships, airplanes, and satellites. Operating the machines cost roughly ten times what it cost to analyze the data they returned.

This TECHINT, or technical intelligence, was augmented to a small degree by HUMINT, or human intelligence. HUMINT is the more dramatic, involving spies and traitors. But TECHINT, the cold warriors found, was the more productive. The CIA certainly succeeded in placing informers in the Soviet Union and sometimes pulled off capers with "Mission: Impossible" daring (see "Kidnapped!" p. 81), but HUMINT was minuscule compared to TECHINT. Mechanical spies could collect infinitely more information than their flesh-and-blood counterparts. They did not lie, distort, or betray. And (certain manned reconnaissance airplanes aside) they could not be caught. So the missile monitoring shell was carefully built, starting around 1953, and took on the job

*In the 1950s, the U.S. Air Force built the Distant Early Warning System, powerful radars that stood guard against a Soviet air attack. Large receivers later eavesdropped on missile and spacecraft telemetry. Opposite, clockwise: The radio telescope at Jodrell Bank, England, was one of several facilities enlisted in U.S. spy service. With phased-array radars on land and sea—Cobra Dane in Alaska and the Navy's Cobra Judy—U.S. spies had the Soviets surrounded.*

of watching space activities the moment Sputnik went up.

There were dish and later phased-array radars and signals-intercept antennas used singly or in combination in Norway, England, West Germany, Turkey, Iran, Pakistan, Communist China, Saipan, Alaska, Hawaii, Antigua, Ascension Island, Greenland, and at several locations in the United States. The radars monitored missile tests and, later, spacecraft (both U.S. and Soviet).

One of the first installations was established by the U.S. Air Force in a remote village in Turkey and had an almost immediate impact on U.S. policy, according to Albert "Bud" Wheelon, a specialist in Soviet rockets and missiles who later became the CIA's deputy director for science and technology. The radar was monitoring, among other things, tests of the SCUD, SS-4, and SS-5 tactical missiles. "When the data came in from the Diyarbakir radar, we were genuinely stunned by the rate at which they were launching," Wheelon remembers. "There had been lots of reports at the time but nothing definitive. This was hard to refute." Wheelon points out that the Eisenhower administration began to perceive the intercontinental ballistic missile as a priority in November of the same year the radar became active, 1953.

An operation in Norway was later set up to monitor tests of submarine-launched ballistic missiles and weather and re-



connaissance satellites, most of which were, and continue to be, sent up from Plesetsk, the northernmost of what were then the USSR's three main rocket launch facilities. (The others were the now-defunct Kapustin Yar, south of what was then Stalingrad and is now Volgograd, and Tyuratam, on the central Asian steppe in what is today Kazakhstan.) The antennas in England included the massive radio telescope at Jodrell Bank, outside of Manchester, which was built for astronomers to study deep space and was operated by Sir Bernard Lovell's brainy graduate students. The antennas in West Germany, staffed by U.S. servicemen, col-

lected missile and space data without the knowledge of the West Germans. The information was recorded on tapes and sent home by regular military air service. The antennas in Iran were situated at two sites, known as Tacksman I and Tacksman II. One, perched atop a 6,800-foot mountain at Mashhad, 700 miles due south of the huge space launch and missile test center at Tyuratam, provided the kind of coverage that warmed the analysts' souls. It could track a missile as it was launched from Tyuratam, arced as high as 1,500 miles over Siberia (while shedding stages and transmitting data), and disappeared over the eastern horizon as it streaked toward Kamchatka, at the edge of the Pacific, where its warhead or warheads came down.

Missile tests and some space launches were also watched by Cobra Dane, a giant phased-array radar in the Aleutians, by radar ships code-named Cobra Judy, and by Cobra Ball's lumbering RC-135 aircraft, which prowled the north Pacific with optical and infrared cameras, radios, tape recorders, and other spy gear. The Cobra program was designed to pick up the missiles after they had been lost by the Iranian sites, thus providing continuous and complete coverage.

COURTESY JEFFREY RICHELSON



UPI/CORBIS BETTMANN



U.S. NAVY



Tacksman I and II were lost when Iranian mullahs staged a coup in 1979 and threw out the pro-American Pahlavi family. That provided a compelling reason to move the operation. According to a reliable source, tracking radars in western China took over the job.

The Soviets had no such worldwide network. They didn't need one for espionage; most U.S. space and missile tests—failures as well as achievements—were reported in a free press for all the world to read. To monitor their own launches the Soviets used tracking ships, customarily positioned to collect telemetry at key points along a spacecraft's reentry path—to know when its engine was turned back on to slow it down, for instance. These launches were routinely followed around the Mediterranean and the Pacific by antenna-laden U.S. spy ships. The same was true for missile tests. U.S. intelligence agencies knew that the Soviet ships' positions were not arbitrary and therefore made special provisions to try to collect the same telemetry.

In 1963 the Air Force extended the missile monitoring shell into space, deploying the Missile Defense Alarm System, satellites that used infrared sensors to detect Soviet missile launches. MIDAS begat the Defense Support Pro-

gram 647 satellites, which today use 12-foot-long infrared telescopes to follow the heat plumes of rockets with considerable precision. Signals-intelligence satellites joined the fleet in 1970, variously code-named Canyon, Rhyolite, Aquacade, Chalet, Vortex, and Orion. Rhyolite used a massive antenna that not only pulled in telemetry from missile tests and space launches but eavesdropped on as many as 11,000 microwave-transmission telephone calls simultaneously, some of them made from Soviet generals' car phones.

The telemetry caught by signals satellites and their populous ground-based brethren described what was happening inside a missile or satellite. In the case of a missile, this information would include rate of acceleration; pressure in the combustion chambers, turbopumps, and fuel and oxidizer tanks; propellant flow rate; turbine speed; and amount of vibration.

Most Soviet telemetry came down on a stream of 48 radio channels, or traces, each carrying a different coded measurement that had to be demodulated from the carrier signal it was on. Like the voices and music on radio and television, telemetry signals ride on electronic beams the way Aladdin rode on his flying carpet. The analyst's job was to



*A September 1968 Corona satellite photo shows twin launch pads at Tyuratam. The launch mounts—at the center of three grates covering flame trenches—are flanked by lightning deflection towers. In an August 1969 photo (right), the pad on the*

*right has been scorched, its flame grates and one lightning tower completely destroyed. The picture is evidence of a July 1969 explosion of a gigantic N-1 rocket (inset) being tested for the Soviet attempt to send cosmonauts to the moon.*



## Kidnapped!

"An absolute measure of weight was obtained by a lucky break," a 1961 CIA journal blandly put it. "Covertly, we were able to acquire detailed data about the upper-stage rocket vehicle, the Lunik stage which mates directly to the Soviet ICBM." The Central Intelligence Agency was "able to acquire" this data because several of its agents had "borrowed" the Soviet spacecraft, photographed its interior front to back, and returned it in its crate the next morning before it was missed.

That brazen—and dangerous—operation happened in 1960, when the Soviet Union was trumpeting its industrial achievements by sending various pieces of machinery to trade fairs in several nations. Having learned to its astonishment that the Lunik was a production item, not a model, the CIA intercepted the touring exhibition's shipping manifest and plotted a way to grab the spacecraft.

One team intercepted the truck carrying the thing as it went from the exhibition site in Mexico to a rail yard, where it would head to its next destination. Before reaching the train, the driver of the truck carrying the crated spacecraft turned it over to another driver. While the first was treated to a night's diversion in a local hotel, his replacement took a detour to a salvage yard, where a second team photographed the Lunik up close in the dead of night.

SOVPHOTO/EASTPHOTO



*In 1959, Luna 3 beamed images from the far side of the moon. A production model of the rocket stage designed to carry it was kidnapped and photographed by U.S. spies the following year.*

Lookouts were posted at strategic positions in the neighborhood. Working in stockings feet so they wouldn't leave scuff marks, the operatives partly disassembled the spacecraft and photographed the payload section, a

main antenna, engine mounting brackets (engine and batteries were not included), fuel and oxidizer tanks, electrical connections, and markings, including the serial numbers of components and where they had been manufactured. The spies worked for a clandestine group called the Joint Factory Markings Center, which provided the CIA and the Pentagon's Defense Intelligence Agency with detailed information about the serial numbers, factory symbols, other markings, and locations of the factories that made aircraft and rocket parts.

With the job finished by dawn, the Lunik was sent on its way, its owners apparently none the wiser. Yet had Lunik's kidnappers been discovered, the KGB undoubtedly would have reported the incident to the international press and landed a political haymaker on their spacecraft's nefarious abductors. One can almost hear how a gloating Nikita Khrushchev would have delivered one of his characteristic taunts: "The imperialist criminals don't have to steal our technology. All they have to do is ask us for it." But

the operation was launched anyway because the benefit was considered worth the risk. It was a decision that reflected a desperate need to know about the opposition's capability—and vulnerability—in space.

get Aladdin off the carpet and find out what he knew.

The key to this procedure was establishing knowns and then extending them in a process that was derivative. "There are indicators that tell you how much fuel is left if it's a maneuvering satellite," says Nick Johnson, who now works at NASA's Johnson Space Center in Texas. (When the Soviet missile and space threat subsided, Johnson began applying his extensive knowledge of what's up there and how to identify it to the problem of space debris, becoming NASA's chief expert on the subject.)

"You have all these data streams coming in," he adds, still thinking in the present tense and savoring the process the way others savor a killer crossword puzzle. "You now have to figure out what part of each word goes back to what thing.... If you've got a spacecraft up there which has maneuvering capability, it therefore has a propellant supply. Somewhere in all those bits is a messenger going back to the Soviets saying 'This is how much fuel I have left.' So as the mission progresses, as you see it do a maneuver, then the value of that bit should be constantly decreasing. And if you can correlate that, particularly with a maneuver, you say 'Ah, [that's the bit that] tells me now how much fuel is on board the spacecraft.' And then you do the same thing with the thermal control system or the electrical power."

Signals intelligence could only provide part of the story, however. A comprehensive portrait of spacecraft and missiles, and even strategies, would emerge only when the analysts took the vital statistics they drew from telemetry and combined them with pictures.

**S**atellites began taking pictures of missiles and spacecraft at launch facilities as part of the heavily classified Corona program, which sent its first picture from space to Earth in August 1960. Now, after a missile took off from Tyuratam, was tracked by radar in Iran, then picked up by the Cobra Dane phased-array in Alaska, Corona would photograph the warheads' impact craters on the Kamchatka Peninsula so the missiles' accuracy could be calculated.

Throughout the cold war, all three missile and spaceflight centers remained priority targets for photo reconnaissance satellites, as well as communication and telemetry intercept satellites. The imagery provided some vivid peeks at not only the opposition's missiles but also the facilities themselves, which provided analysts with still more information about Soviet capability. Corona imagery showed that the Vehicle Assembly Building at Tyuratam was a quarter of a mile long, for example, giving a clear indication that several rockets could be prepared for launch simultaneously.





*CIA analysts scanned film from aircraft and satellites with a cartful of reference materials, including previous photos, nearby. (Note the map of Vietnam leaning against the wall.) If they found something suspicious, they mounted the film on a micro-stereoscope (below) to get a better look.*

On August 3, 1969, one of Corona's KH-4B (for KEYHOLE) satellites returned a picture of a launch pad at Tyuratam that had been severely burned; earlier, a KH-4A got a spectacular shot of a giant N-1 rocket on another pad. Combined with intercepted telemetry and radio chatter, the pictures proved that the USSR was trying desperately to send a cosmonaut to the moon in competition with Apollo. The photos of the scorched pad were so clear that, according to Dino Brugioni, a top CIA photo analyst who helped brief President Kennedy during the Cuban missile crisis, interpreters could see that a baffle plate had been blown off its base and a lightning arrester mangled. Those observations proved that at least one of the white, skyscraper-size launch vehicles had met with disaster. (All four launch attempts failed.)

The imagery's resolution—the size of objects that could be discerned—was nine feet for the KH-4A and six feet for the KH-4B. Within ten years resolution would improve to less than a foot and then, under ideal conditions, six inches. And thanks to the use of electro-optical cameras on the advanced KH-11s, which first went into orbit in December 1976, reconnaissance satellite imagery also began to move in near-real time—virtually as the event was taking place.

Russian rocketeers at Tyuratam and their Chinese counterparts at Shuang Tseng Tsu knew perfectly well that the U.S. satellites were taking their pictures, says Brugioni. The Russians often reacted by stamping obscene messages (in Russian) in the snow for the analysts at the National Photographic Interpretation Center in Washington. The Chinese, he says, did the same thing with rocks.

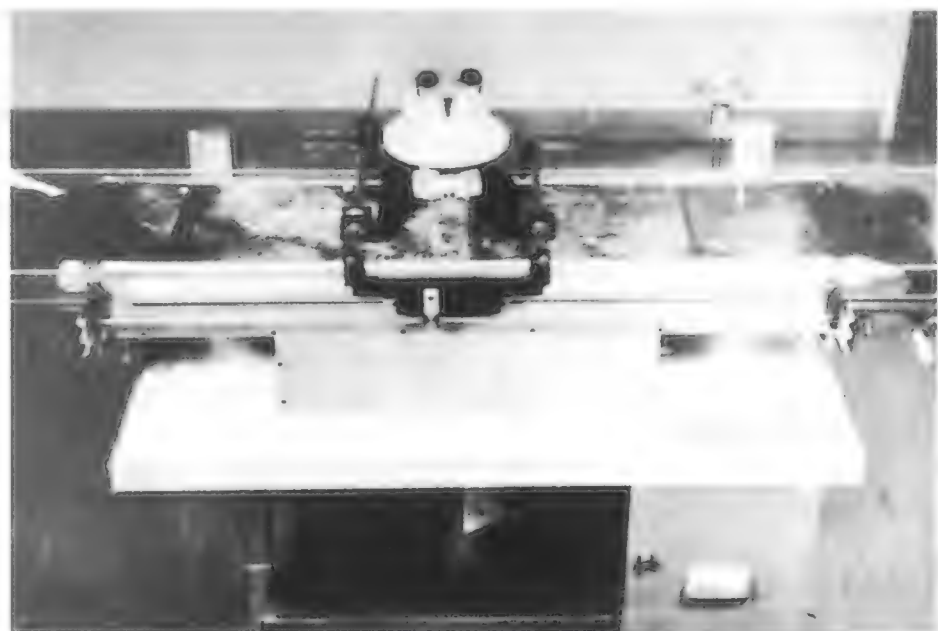
In order to prevent the Soviet Union from turning the tables on U.S. spy satellites by intercepting their intercepts and the other data they collected, the snoopers beamed their

take to still other satellites, which in turn relayed it to Earth. Ambiguously named Satellite Data System spacecraft began handling that chore when the first KH-11 went up. A decade later, the task was given to NASA's Tracking and Data Relay Satellite System, or TDRSS. The satellites were ostensibly designed to relay communication between space shuttles and ground stations, a function they also perform. But TDRSS also uses large solar panels and 16-foot antennas to receive and relay KH-11 imagery in real time to stations on the ground and to re-route radar imagery from satellites that had started their lives code-named Lacrosse (the name has since been changed a number of times).

And they relayed telemetry intercepts from the ring of foreign collection sites, making it possible in 1988 for this intelligence to move in real time.

Before the photo reconnaissance satellites were in operation, the U.S. Air Force's three-ton Baker-Nunn optical tracking cameras caught Soviet spacecraft in action. The cameras were replaced in the mid-1980s by five Ground-based Electro-Optical Deep Space Surveillance (GEODSS) sites, which send pictures of satellites directly to U.S. Space Command's Space Surveillance Center in real time.

Sometimes the best place for a camera was not in orbit around Earth nor on an isolated mountaintop but in the hands of people who could walk right up to their subjects and snap their pictures. Military attachés from NATO countries routinely photographed the missiles that were trundled through Red Square on Revolution Day every November. The first appearance of the Soviet SS-10 missile—known in the West as the "Scrag"—in a 1965 parade yielded photos that went straight to West Germany, where they were pored over by Air Force analysts before being forwarded to the Air Force's Foreign Technology Division (now the National Air Intelligence Center) at Wright-Patterson Air Force Base in Ohio.







There, they were studied in even greater detail by analysts, who logged three and a half man-years in one week.

The Paris Air Show provided another photo-op. Johnson, who by 1981 was Teledyne Brown Engineering's principal technologist, visited the Soviet pavilion that year and photographed every detail of every operational spacecraft he could find. The assumption was that the same technology that went into communication and weather satellites, and even into manned spacecraft such as Vostok, also showed up on the military side.

So while most other photographers were shooting whole spacecraft for trade journals or posing beside them for souvenir shots, Johnson used his close-up lens to record such arcane matters as whether solar arrays were bolted, riveted, or welded to the spacecraft. Johnson's photographs contributed to a vast electronic catalog that bulged with information about every satellite's inclination, altitude, nodal period (the time it takes to make one orbit), weight, shape, size, apogee, perigee, eccentricity (the shape of the orbit), launch time and date, and more. And the data piled up very quickly: by the mid-1960s an average of 10,000 satellite observations were made each day, and by 1990 five times that many came in for analysis. Johnson's close-ups contributed by not only showing how Soviet satellites worked but providing guidelines for disabling them if a space war broke out.

Missiles and spacecraft in trade shows, airshows, and parades were fair game for spies because they tended to be the real articles, not replicas. That was because the Kremlin was caught in its own dilemma. The point of displaying spacecraft was to project Soviet technological superiority (and therefore the invincibility of Communism). But that could

*The first location of the CIA's photo analysis center blended into the cityscape at 5th and K Streets in Washington, D.C. Analyst Dino Brugioni stands on the sidewalk. (The center moved to the Navy Yard in 1963.)*

not be done with mere models. Using obvious copies would have invited ridicule—biting references to Potemkin spacecraft on phantom missions—and the USSR was notoriously thin-skinned where the West was concerned. Some secrets had to be sacrificed for both politics and pride.

But prideful politics played a role in the space and intelligence programs of both superpowers. In 1961, Bud Wheelon and Sidney N. Graybeal, experts on Soviet rockets and missiles, offered a rationale for intelligence gathering in an article published in a secret CIA journal. The authors drew a classic analogy between space espionage and coaching college ball: "A college football coach, spurred by a vigilant body of alumni to maintain a winning team, is expected to devote a great deal of energy in what in a more deadly competition would be called intelligence activity. He must scout the opposition before game time and plan his own defense and offense in the light of what he learns. During a game he must diagnose plays as they occur in order to adjust his team's tactics and give it flexible direction in action.... Although both alumni and coach recognize that football has little to do with the true purpose of a college, the coach is under relentless pressure to win games because his team, in some intangible sense, stands for the entire college."

The analysts were a patriotic group and also confirmed geeks. They lived with imagery and intercepted signals so



intimately that they knew the various Soviet missiles and spacecraft as well as they knew their children's report cards (maybe better). Mention an SS-12, an SS-N-17, or an SS-19 and the analyst turned into a Quiz Kid with a top-secret clearance, proudly ticking off the particular beast's size, throw weight, range, propellant and oxidizer, vibration and acceleration rate, stage separation sequence, specific impulse (a measure of the time it takes an engine to use a pound of fuel to produce a pound of thrust), and lots more.

"I found it one of the most exciting chapters of my life," says Wheelon, who holds a doctorate in physics and who designed ballistic missiles before working for the CIA in the 1960s. "I found that doing this telemetry analysis and technical intelligence analysis was the closest thing to physics. If you started out with a great big question mark—enigma, confusion—you got a theory," and then the theory was refined by "being bounced back and forth. It was a period of just extraordinary excitement as we began to unravel this puzzle. They didn't have to pay us. It was so interesting and exciting, just solving these crossword puzzles."

Practitioners of the black art got so good at decoding telemetry from space that they could differentiate between the heartbeats of a man, a woman, and an animal. They also pried open television signals. Before Yuri Gagarin had completed his single orbit on April 12, 1961, National Security Agency analysts at Ft. Meade, Maryland, reported that a real-time readout of the coded video signals coming from his Vostok spacecraft confirmed that there was a living cosmonaut in orbit.

In the end, despite the astounding inventory of intelligence machines that the United States amassed over the decades of the cold war, spying is a human activity, born of human fears and profoundly influenced by human behavior. However dispassionate they tried to be, analysts faced with a stupefying amount of data, much of it redundant or irrelevant, constantly came up against human limitations. Johnson, among others, points out that coming up with the technical details of a weapons system was a long way from forming an operational picture of it—achieving "fusion," as he puts it.

One of the great fears of the 1960s, for example, was that the Soviets would develop a weapon that could evade U.S. ballistic missile early-warning systems. So when the SS-10 Scrag missile debuted in that 1965 military parade, the intelligence community leaped to the conclusion that here was the launcher for that dreaded weapon: the so-called Fractional Orbital Bombardment System. FOBS could send nu-



NICHOLAS JOHNSON

At a 1981 Paris Air Show, Nick Johnson zoomed in on a Soviet comsat's antenna and waveguides.

clear weapons to orbit (or partial orbit, hence "Fractional") and then decelerate them to drop on Western targets. In fact, the Soviets did begin testing FOBS the following year, but not with the SS-10. Moreover, establishing the technical fact, as the spooks did, that the Soviets conducted 18 FOBS tests between 1966 and 1971 and trying to deduce when and how they would use FOBS were two very different matters.

Soviet motives and mindsets were not the only obstacles to achieving fusion; human nature was another. The whole process of intelligence collecting was mired in competitive sniping and politics. While the members of the community tended to work in harmony during crises such as the smuggling of ballistic missiles into Cuba in 1962, the rest of

the time they routinely hammered one another.

The wars between the Air Force and the CIA are legendary. One of the most rancorous had to do with deciding whether the Soviets' SS-8 missile was big enough to carry a 100-megaton warhead, as the Air Force contended, or whether it was far smaller, which was the CIA position. The airmen used the specter of a colossal SS-8 to justify their Titan ICBM program, according to one veteran of the debate, who added that the two sides practically had a fistfight over the issue. The CIA, in this instance, was right.

Spy agencies invoked ultra-secret, highly compartmentalized, "need to know" status on their juiciest operations—the so-called deep-black programs—to thwart not only the Communists but one another. Many of the most thoughtful people in intelligence deplored what they saw as excessive secrecy because the compartments prevented information sharing that could have made the analytical process more efficient.

Somehow the data was refined and discussed by the various agencies—the National Security Agency, CIA, Department of State, and military intelligence services—that were represented on a joint board. The results then went into National Intelligence Estimates, or NIEs, which were reports that were supposed to describe developments in the USSR and predict where the Kremlin's various programs were going. Often the material was also turned into articles for classified journals such as the Air Force's *Air Intelligence Digest* and the Office of Naval Intelligence journal, *ONI Review*.

The NIEs were the final products of the intelligence process, in which Soviet operational capabilities and intentions had to be inferred from technology alone. The record of the NIEs, which are punctuated by "probably" and "possibly,"



indicates that the analysts were generally pretty good. Yet they would have been no match for the Oracle of Delphi.

One of the missile and space spies' first notable successes was to knock down the notion that there was an ICBM gap favoring the Soviet Union, a notion the Air Force promoted by the highly selective use of intelligence, according to one expert, who added that competitive analyses by the CIA and the armed services were started precisely to prevent such distortion. "An exhaustive re-examination has failed to establish Soviet ICBM production rates or to provide positive identification of any operational ICBM unit or launching facility other than the test range," an NIE concluded in May 1960.

The same report, however, was wrong in predicting that the earliest possible launch date for a Soviet surveillance satellite was 1960 (it was 1962) and that 1960 would also be the earliest the Russians could send a spacecraft around the moon and soft-land on it (neither was done until 1966). The authors were right on the mark in predicting that a man would be sent into orbit in "late 1960 or 1961" (it was Gagarin's flight) but were wrong in predicting a manned circumlunar flight in 1964 or 1965 and a manned landing in about 1970.

An NIE written in 1963 reported that the analysts had found no hard evidence that the Russians planned to orbit a nuclear-armed satellite and noted that preparing a large number of them for launch on short notice would have been "extremely complex and expensive." But the analysts added that the USSR did have a very limited capability to get a few nukes into space if they felt they had to. The USSR is not known to have ever orbited a nuclear weapon. Perhaps the spooks were right and the Soviets never felt threatened enough to do so.

They were dangerous times, Johnson recalls, adding that both sides ultimately managed to "dodge the bullet." Yet he and many others (presumably including the opposition) profoundly enjoyed and were fulfilled by the challenge of connecting an almost infinite number of dots in the great space puzzle until a picture emerged (or seemed to) and then applying what was in the picture to the military and space operations of a closed society.

One especially insidious way to apply intelligence to ASAT work, at least in the view of the cognoscenti, is not to shoot at the enemy's satellites or zap them with lasers but to bedevil them and their operators by breaking into their telemetry and slipping in false information.

Would it work? Or would the satellite's operators make it *seem* as though it had worked while getting what they wanted anyway, thereby out-foxing the foxes? Or would the foxes let

the opposition think they (the foxes) had been outsmarted, knowing that the data was getting through and being monitored, while the opposition thought that the foxes thought that it was being compromised?

"It's a remarkable kind of activity; it's a lot of fun," Johnson says, laughing heartily at the always intriguing but potentially deadly game that he, Graybeal, Wheelon, Brugioni, and the others played for so long. "I had some of my best fun in those years."

And now that the cold war has ended, the information still has its uses. Johnson's 1981 Paris Air Show pictures came in handy for a brief course he taught on Soviet spacecraft design during a 1994 conference sponsored by the U.S. Department of Defense. He teamed up for the course with Professor Grigoriy Chernyavskiy, the chief designer at the Krasnyosk design bureau. Two better instructors would have been hard to find, though their collaboration is ironic. Chernyavskiy was responsible for the design and operation of certain low-altitude Soviet spacecraft that were potential targets of U.S. anti-satellite weapons systems. Johnson became an expert on the same spacecraft Chernyavskiy designed in order to advise the U.S. military about technologies that could destroy them. ➔



*Among the data relayed by NASA's Tracking and Data Relay Satellites is the cache of digital images and signals pulled in by U.S. spysats.*



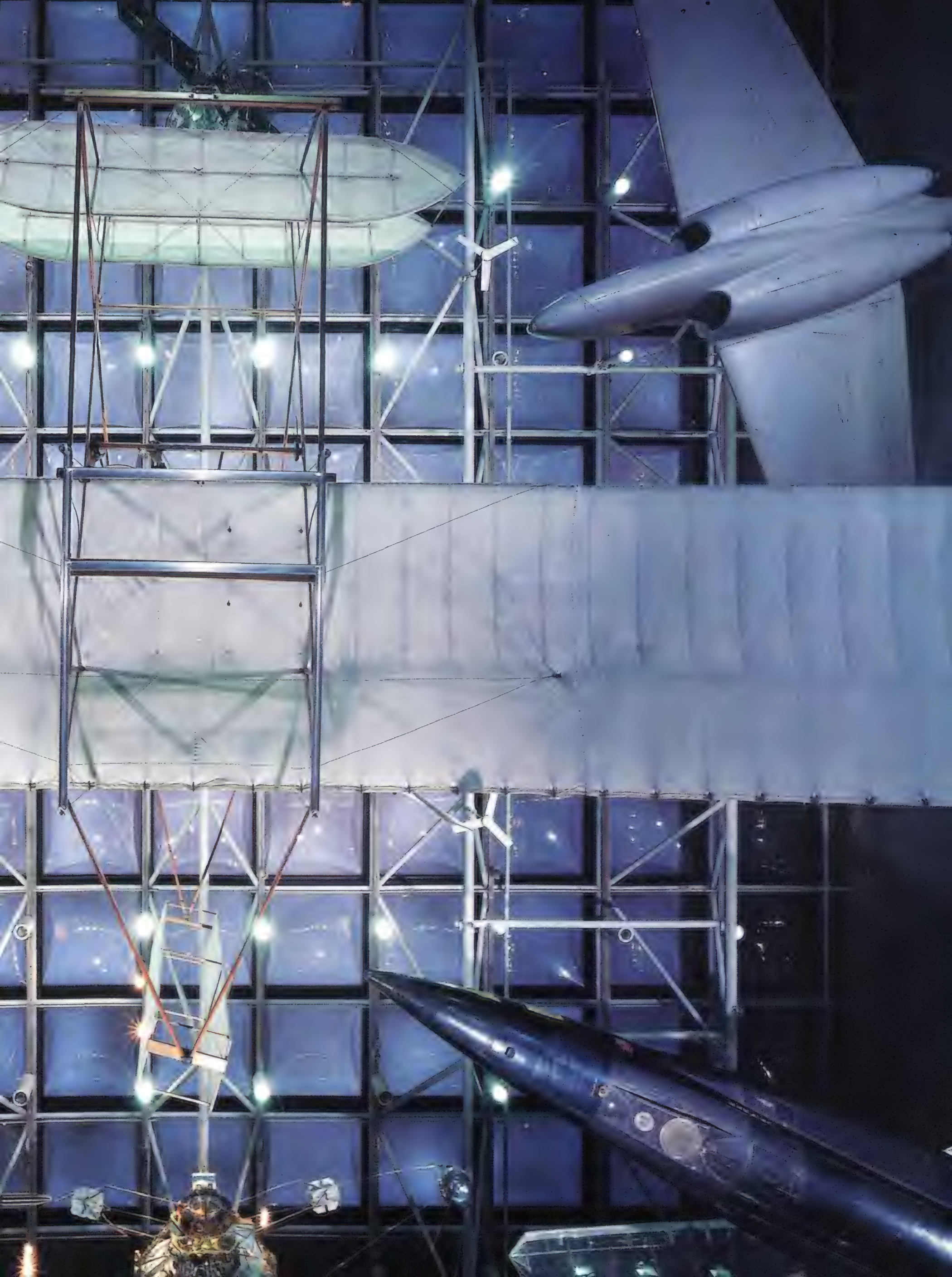
## >SIGHTINGS<

Given the assignment to produce an image for a book cover that embodies the history of flight, National Air and Space Museum photographer Eric Long lay flat on his back in the Milestones of Flight gallery, searching for inspiration. When it came to him, Long scrounged around the country and found a specialized camera at Calumet Photographic in Bensonville, Illinois, with the equivalent of a 13-mm lens, which would capture the entire ceiling of the gallery. With the borrowed camera, "I reserved an evening in the Museum when nothing was going on—a rarity," he says. Assisted by NASM chief photographer Mark Avino and staffer Tim Cronen, Long set up high-intensity lights (clockwise from lower left): two each on the *Spirit of St. Louis*, the X-1, the XP-59A, three on the X-15, and four on the *Flyer* (center). "The black X-15 was the hardest," says Long. "Back light was used to produce an outline of the plane to define it."

The project began at 6:45 p.m. and ended at 1 a.m., and the equipment was left up for a morning shoot. Long spent the night on his office floor and began shooting at six the next morning. "I'm not enthusiastic about spending nights in the office," he says, "but the results of this shoot and the team effort that went into it made it very worthwhile."









## Windy City Hero



**Fateful Rendezvous: The Life of Butch O'Hare** by Steve Ewing and John B. Lundstrom. Naval Institute Press, 1997. 358 pp., b&w photos, \$32.95 (hardcover).

The authors set themselves quite a challenge—writing a full-length biography of someone revered as a hero but who made his most noteworthy contributions over a period of only 21 months, ending in his mysterious death at age 29. Butch O'Hare was a celebrated World War II Navy carrier pilot and Medal of Honor recipient.

The result is a book that will appeal to both World War II aviation enthusiasts and to scholars wishing for an in-depth investigation of O'Hare's family and background. However, enthusiasts will probably enjoy this book more if they scan much of the background material and concentrate on the aerial and naval encounters described well in clearly demarcated chapters, which draw from

Japanese as well as American sources.

For me, at least, the most startling background revelation was that O'Hare's father was murdered gangster-style in Chicago in 1939, while Butch was in flight training at Pensacola. It's ironic that 10 years later Chicago's new airport was named in Butch's honor.

One of the books' strengths is the 13 maps and diagrams that put the individual actions at far-flung Pacific islands in context and help clarify O'Hare's famous first and infamous last air encounters.

It bears remembering that the first battle, on February 20, 1942, occurred barely two and one half months after Pearl Harbor. Yet here was the U.S. Navy challenging the Japanese base at Rabaul, in the far southwest Pacific. The Japanese launched 17 Mitsubishi G4M "Betty" medium bombers against the *Lexington* and her escorts. "Jimmy" Thach led the destruction of the first nine. When the smoke cleared, only O'Hare and one

other pilot were in position to face the second wave of eight bombers. But when the guns on the other pilot's F4F refused to fire, O'Hare coolly attacked the well-armed bombers in four separate passes, destroying four (he has long been credited with five) and damaging others. The *Lexington* and escorts escaped damage and only two of the Japanese attackers returned to base.

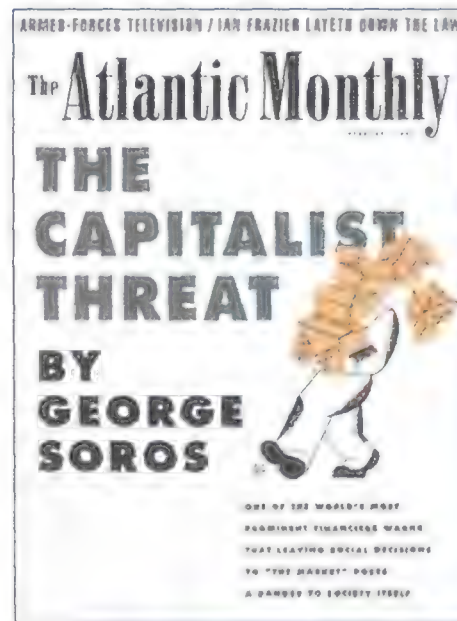
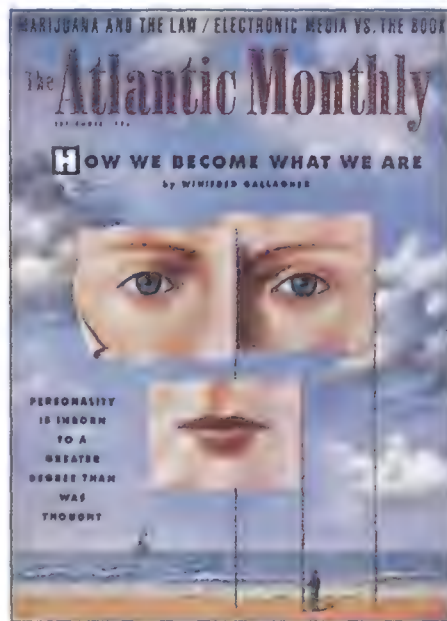
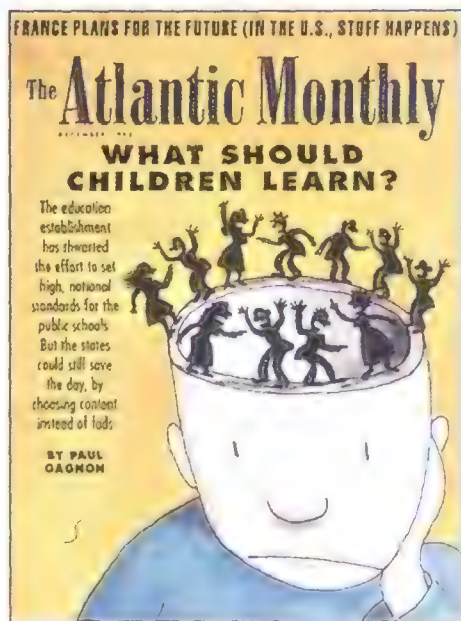
O'Hare was an instant hero. He participated in one more daring raid by the *Lexington's* air wing flying across the Owen Stanley Mountain range to Japanese bases at Lae and Salamaua, New Guinea. Shortly after, on April 21, he and his new wife (he had proposed on their first date five months before Pearl Harbor) were in the White House, where President Roosevelt presented him with the Medal of Honor and a promotion to lieutenant commander.

The authors describe O'Hare's tedious chores at patriotic functions and war bond rallies, and his return to active flying in Hawaii, mostly on Maui. By June 19, 1942, he had replaced Thach as commanding officer of Navy Fighting Squadron Three, and on October 13, 1943, he became commander of Carrier Air Group Six (CAG-6). The authors do their best to make sense out of the intervening 16 months of confusion, when O'Hare's charges were constantly being shuffled between squadrons, air groups, and ships. Apparently, much of the confusion was due to the Navy's having more pilots than carrier billets after the *Lexington* was lost in the Coral Sea and the *Yorktown* at Midway. In any case, O'Hare used this time to train several pilots and squadrons and to switch from the barely adequate F4F Wildcat of his first battles to the F6F Hellcat, which completely dominated the Mitsubishi Zero later in the war. This Maui "interlude" included carrier raids on Marcus and Wake islands. At the latter, O'Hare downed a Zero and another Betty.

By mid-November, the new commanding officer of CAG-6 had embarked on the *Enterprise* to support the landings on Makin Atoll, north of the



# Dig deeper.



## Just \$1 an Issue

WITH what critics call “uncanny” prescience, *The Atlantic Monthly* delves beneath the events of the day to explain the forces shaping your world. Outstanding writers like Eric Schlosser, Nicholas Lemann and Robert Kaplan explore the nation’s economy, public policy and foreign affairs. Plus award-winning short stories, poetry, reviews, travel, food and music. All for only \$1 an issue – \$12 for a full one-year subscription.

“*The Atlantic* is, quite simply, the best general interest magazine available on the newsstand,” raves the *Toronto Star*. To subscribe, mail the attached card today.

The **Atlantic Monthly**  
Box 52661, Boulder, CO 80322-2661

THE KNOWLEDGE YOU NEED FOR THE WORLD YOU LIVE IN



much bloodier Marine assault on Tarawa. The Navy task group was within range of Japanese bombers in the Marshall Islands. Unable to effectively engage the U.S. ships by daylight, the enemy began using torpedo-armed Bettys to stage night attacks. Remarkably, the Navy had no night air defense doctrine, save for the use of anti-aircraft guns. In less than a week, O'Hare devised effective night tactics combining Hellcats with radar-equipped TBF Avengers. Unfortunately, these innovations were not yet perfected, and O'Hare was lost in a botched night rendezvous on November 26, 1943. The authors explore the possible causes of this tragedy, but it remains a mystery who, if anyone, shot down Butch O'Hare.

—Sam Smith is a commercially licensed pilot and amateur aviation historian.



**Project Coldfeet: Secret Mission to a Soviet Ice Station** by William M. Leary and Leonard A. LeSchack. Naval Institute Press, 1993. 153 pp., \$27.95.

*Project Coldfeet* comprises a spy tale,

Arctic adventure story, scientific narrative, and personality study. Intelligence historian William Leary has teamed up with Leonard LeSchack, a former naval engineering officer who participated in this project, to spin a most unusual yarn.

For over a century, scientists and explorers have been drawn to the northern Arctic regions. Hardy researchers built temporary camps on drifting ice floes and measured ice thickness, water currents and temperature, magnetic forces, and meteorology. The Russians took the lead in these efforts, not surprising given their proximity, but after World War II the United States began looking north in earnest.

As the cold war settled in, nuclear war between the two superpowers became a distressing possibility. If such a cataclysm were to occur, it would take the form of an air assault by long-range nuclear-armed bombers flying over the North Pole—the shortest route between the United States and the Soviet Union. U.S. military planners realized they needed to learn more about the area along this flight route. Their interest became more pressing when submarines, carrying nuclear-tipped ballistic missiles, began

entering service in the 1960s. The subs' patrols would take them near and even under the polar ice cap. What conditions existed there, and how could a vessel navigate under a ceiling of ice?

Realizing the Soviets were far advanced in such research, the Americans hastened to catch up, and fortuitously, an opportunity to do that came along in 1962. The Soviets had recently abandoned one of their scientific ice stations, which was not unusual, as the shifting ice floes inevitably crashed into one another, causing fractures and fissures in the surface. Because ice stations had to be placed on floes large enough to accommodate a runway for support aircraft, a serious collision could threaten the existence of the runway and hence the station's lifeline. That's exactly what happened to Soviet ice station NP8 in March 1962, necessitating a hasty evacuation.

Enter the spies and adventurers. Navy lieutenant Leonard LeSchack and Air Force major James Smith saw a fleeting opportunity. The two men devised a scheme to visit the abandoned station and explore its many secrets before it was destroyed by the shifting ice. Their scheme, Project Coldfeet, bordered on the bizarre, and sounded like it was conceived by a master spy novelist.

LeSchack and Smith proposed to parachute onto the ice floe and for several days examine the camp and its equipment. There they would glean as much intelligence as possible regarding the nature, sophistication, and depth of Soviet scientific and military efforts to explore the ice cap and the water beneath it. Getting off the ice floe would be a problem: NP8 was so deep into the floating ice pack that neither helicopters nor ice-breaking ships could reach it. The answer came from inventor Robert Fulton, who designed a "skyhook" system that could pluck crews from dangerous territory and reel them into rescue aircraft (see "Queasy Rider," *Above & Beyond*, Aug./Sept. 1996). The challenges were great—during practices for the mission using dummies, the pickup system was successful only about half the time.

The mission took place in May 1962. LeSchack and Smith spent five days on NP8; they were recovered safely and brought back a priceless trove of equipment and information regarding Soviet advances in polar science. Although LeSchack and his comrades were celebrated and decorated, this courageous exploit remained classified for three decades, until William Leary came along to reveal it.

—Air Force Colonel Phillip S. Meilinger is a professor of strategy at the U.S. Naval War College in Newport, Rhode Island.

**Women Who Dared** by Yvonne Pateman, Lt. Col., USAF (ret.) Norstahr Publishing, 1997. 136 pp., b&w photos, \$29.95 (hardcover).

Chuck Yeager broke the sound barrier in October 1947. But how many people know that in October 1944 Ann Baumgartner Carl became the first American woman to fly a jet fighter or that Jackie Cochran broke the sound barrier in 1953 (with Yeager flying the chase plane)?

In *Women Who Dared*, we also learn about Geraldine Cobb, who passed all the examinations used to select the original seven Mercury astronauts and was qualified for spaceflight in 1961. Despite the fact that 13 other women also passed the initial battery of tests, the program to consider female astronauts was canceled before in-depth testing could take place. During July 1962, the Congressional Subcommittee on Selection of Astronauts held hearings in which testimony was offered about the suitability of women for spaceflight. It was revealed that the female candidates' total flying time averaged 4,000 hours (twice the average total time of the men) and that in some ways women had physical advantages, such as being less prone to heart attacks. But further consideration of female astronauts still came to an end.

Yvonne Pateman's book is organized by eras and military services. The chapters that deal with the contributions of women in the early days of aviation and the beginning of the WAFS and WASP programs are fascinating and packed with emotion. The later chapters about women aviators and astronauts feel rushed and read more like official biographies from a



military public affairs office. Because the biographies go from era to era and service to service without transitions, this section of the book leaves you wanting more information. Perhaps that's the author's intent.

—Jayne Schlenker, a chief master sergeant in the Air Force Reserve, started her career as a WAF (Women in the Air Force). She is a member of WIMSA (Women in Military Service to America).

**America's Aces in a Day** by William N. Hess. Specialty Press Publishers, 1996. 176 pp., \$19.95 (hardcover).

Many World War II pilots shot down five or more enemy aircraft, earning the title "ace." However, only 106 U.S. fliers distinguished themselves by earning it in



a 24-hour period. William Hess of the organization American Fighter Aces tells the pilots' tales both from actual combat reports and interviews with the pilots.

Early in the war, opportunities to become an ace in a day in the Pacific theater often came during bomber attacks. Where there were bombers,

there were fighters for cover. Marine pilot Captain Joe Foss recounts how he chased a Zero that was on the tail of a Grumman Wildcat.

After the Japanese pilot turned to meet him head-on, Foss opened fire and the Zero pulled straight up. Foss, also in a Wildcat, went vertical too. As he prepared to fire again, Foss saw his opponent climb out of the cockpit onto the wing. Foss pulled the trigger as the Japanese pilot jumped clear, and seconds later, the Zero exploded into flames.

The first P-51 pilot to become an ace in a day was Lieutenant Carl J. Luksic of the 352nd Fighter Group, who attained that exclusive status on May 8, 1944. Hess makes the case that another pilot flying that day, Major James H. Howard, did not receive the credit he deserved. According to the testimony of the bomber pilots he defended, Hess says, Howard should have been credited with six victories rather than the three he reported for himself.

Hess' book is meticulously researched, offering an appendix of pilot names, categorized by branch of service, that includes the dates they attained ace status in a day, and he provides helpful context by noting that as the war lengthened, the Japanese and Germans were forced to send pilots with minimal training into the air against seasoned Americans, thus allowing even more U.S. aerial victories. In addition, the United States designed and launched outstanding new aircraft that further decreased the loss of experienced American pilots.

*Aces in a Day* is an authoritative source for anyone researching this unique fraternity.

—Alyson Behr, a technology and aviation journalist, is a competition aerobatic pilot.

**Flight Path** by Jan David Blais. Highpoint Press, 1996. 481 pp., \$22.95 (hardcover).

Set in what might be considered the most tumultuous years of the airline industry's recent history—1979 through 1983—*Flight Path* kicks in the boardroom door at fictional BellAir's world headquarters. Blais reveals the inner workings at the top of BellAir as the airline struggles to cope with a terrorist attack, deregulation, the

firing of the nation's air traffic controllers, an unfriendly takeover, an ugly labor dispute, and a fatal crash.

*Flight Path* has three main characters: Charlie Bell, the founder of BellAir and last of the industry's old guard; Frank Delgado, the bootstrapping owner of a small Northern California commuter line; and Philip Hartley, the young executive brought in by Bell to rid the airline of its dead wood. Supporting these men are a score of lesser characters, each crafted to present some facet of this high-pressure business.

Bell realizes the world in which he did business has irrevocably changed, and not necessarily for the better. He brings Hartley in and advances him along the fast track to the presidency of the airline. It doesn't take long for Hartley to reveal himself as an unprincipled egomaniac. He negotiates contracts, then begins to chip away at them, once telling his operations manager: "...it's not just this deal. It's every deal! I'm talking attitude!" He touched his finger to his forehead. 'You've always got to be thinking, what can I do to improve my position? How can I squeeze a little more out?'

Hartley has only one item on his agenda: the advancement of Philip Hartley. He is a cancer that has invaded the airline, and as such, his influence grows and deadens everything it touches. Hartley's coalition fires Bell and pushes him off the board of directors. He is ultimately destroyed by his heir's greed and ambition.

Delgado's relationship with Hartley starts out badly and deteriorates as the story unfolds. Hartley's initial dislike of

Delgado turns to hate as Delgado stands his ground in response to BellAir's bullying. Eventually, when Delgado's attention is desperately needed elsewhere, Hartley tries to position himself to take over his enemy's little commuter line.

In the end, Hartley gets his just deserts and Delgado prospers, but not without a tense meeting between the two men. While losing everything, Hartley, it seems, may have learned something about honor and trust. Maybe, the author implies, there was some good buried deep within Philip Hartley after all.

*Flight Path* may not run your pulse up to dangerous levels, but it will get you rooting for the good guys. And when Philip Hartley's life hits the fan, a sneaky smile will almost certainly creep across your face.

—Mark W. McKellar is a Massachusetts-based freelance writer who concentrates on aviation and naval history.

## BRIEFLY NOTED

**The Cold Blue Sky: A B-17 Gunner in World War Two** by Jack Novey. Howell Press, 1997. 183 pp., b&w photos, \$24.95 (hardcover).

The book has a pleasant, personal feel, as if the author is writing an extended letter to you from the European theater.

**Flying Officers of the United States Navy 1917–1919** Shiffer Publishing, 1997. 302 pp., b&w photos, \$49.95 (hardcover).

Originally published just after World War I, this reprint provides a roll of aviators who served in "the Great War" and features a history of Naval aviation as well as an introduction by then-Assistant Secretary of the Navy Franklin Roosevelt.

**Advanced Aerobatics** by Geza Szurovy and Michael Goulian. McGraw-Hill, 1997. 236 pp., b&w photos, illustrations. \$24.95 (paperback).

A how-to manual for horizontal inside snap rolls, vertical rolls, gyroscopic maneuvers, and other nausea-inducing antics. Includes features by aerobatic superstars like Patty Wagstaff and Phil Knight.

**Basher Five-Two** by Scott O'Grady with Michael French. Doubleday, 1997. 134 pp., b&w photos. \$16.95 (hardcover).

The now-familiar tale of Scott O'Grady's rescue after his F-16 Fighting Falcon was downed over Bosnia; but written for young readers.

**Voyages Through the Universe** by Andrew Fraknoi, David Morrison, and Sidney Wolff. Harcourt Brace, 1997. 648 pp., b&w and color photos, illustrations. \$58.95 (softcover).

Although it's a college textbook, this lavishly illustrated volume, which includes Hubble Space Telescope imagery, is available to the general public. A good overview of planetary science, the birth of stars, black holes, astronomical instruments, comets and asteroids, and recent discoveries.







### September 5-7

"Thunder in the Air" Airshow. Thunder Bay, Ontario, Canada, (800) 667-8386.

### September 6 & 7

Fina Dallas Air Show. Featuring wing-walker Lee Oman. Love Field Airport, Dallas, TX, (214) 350-1651.

Great Hagerstown Air Show. Washington County Regional Airport, Hagerstown, MD, (301) 739-2015.

Mid-Eastern Regional Fly-In. Marion, OH, (513) 849-9455.

### September 7

Brooklands Aviation Festival and Flying Display. Brooklands Museum, Weybridge, Surrey, England, phone (01) 932 857381.

Pottstown Aircraft Owners & Pilots Fly-In Breakfast. Pottstown-Limerick Airport, PA, (610) 277-7022.

### September 8-10

Reunion: U.S.S. *Chenango* (all squadrons). Charleston, SC, (520) 803-9316.

### September 10-14

Reunion: 484th Bomb Group, 15th Air Force. Fairview Park Marriott, Falls Church, VA, (310) 316-3330.

### September 11-13

Reunion: National World War II Glider Pilots. Memphis, TN, (770) 972-7100.

### September 11-14

Reunion: Pilot Class 44-K. Marriott Hotel, Colorado Springs, CO, (714) 721-4190.

### September 14-18

Reunion: 325th Fighter Group, U.S. Army Air Forces. Monte Carlo Resort and Casino, Las Vegas, NV, (616) 731-2421.

### September 17-21

Reunion: 455th Bomb Squadron, 9th Air Force. New Orleans, LA. For more information, write: Ed Christiansen, 1712 Apple Street, Metairie, LA 70001.

### September 20

Sulphur Springs Sport Aviation Fly-In. Sulphur Springs, TX, (903) 885-5525.

### September 20 & 21

Confederate Air Force Airshow and Dinner Dance. San Marcos, TX, (512) 396-1943.

Old Fashioned Fly-In. Whiteside County Airport, Rock Falls, IL, (630) 513-0642.

"Planes, Trains, and Automobiles." Mid Atlantic Air Museum, Reading Regional Airport, PA, (610) 372-7333.

## Custom Aircraft Replicas

Models so realistic, you expect them to take flight...



We specialize in custom mahogany replicas. Virtually any aircraft from World War I through present day. Squadron Group orders welcome!

Call today for your free color brochure and see the quality our customers have come to expect.

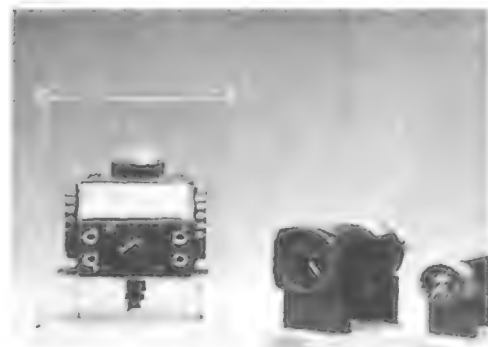
(800) 732-6875 or (316) 788-0128

### Anderson

*Fine Scale Replicas*  
405 Osage Derby, Kansas 67037

## B-52 MELT DOWN

We saved a few cockpit gauges, yokes, phenolics, and ejection seats.



Each is specially mounted for display in your office or home.

Download our catalog, free:  
[WWW.BHAF.COM](http://WWW.BHAF.COM)  
or send \$5.00 for catalog (you will receive a \$10. credit) to:  
BHAF  
8306 Wilshire Blvd.  
Hangar 2659  
Beverly Hills, CA 90211-2382

1-800-355-BHAF

Presenting...

## The DR® FIELD and BRUSH MOWER

-- the amazing walk-behind brush cutter that --

- **CLEAR & MAINTAINS** meadows, pastures, roadsides, fences, wooded and rough non-lawn areas with ease. Mows over 1/2 acre per hour!
- **CUTS** tall grass, weeds, brush, brambles, sumac - even tough saplings up to 1" thick!
- **Plus CHOPS/MULCHES** most everything it cuts: leaves NO TANGLE of material to trip over or to pick up like hand-held brushcutters and sicklebar mowers.
- **POWERFUL 8HP** Briggs & Stratton engine; optional Electric-Starting. **BIG 20" SELF-PROPELLED WHEELS** roll through ditches, furrows, over bumps and logs with ease.
- **Perfect for low-maintenance wildflower meadows...** European-style woodlots free of undergrowth...walking paths...or any area that you only want to mow once a month...or once a season!



So, WHY MESS with hand-held brushcutters that are so dangerous, slow and tiring to use...OR with sicklebar mowers that shake unmercifully and leave a tangled mess?

**CALL TOLL FREE**  
**1(800)614-1818**

Please call **TOLL FREE** or mail coupon for **FREE DETAILS** about the Amazing **DR® FIELD and BRUSH MOWER!**

**TRY FOR 30 DAYS RISK FREE!**

**YES!** Please rush complete **FREE DETAILS** of the **DR® FIELD and BRUSH MOWER** including prices, specifications of Manual and **ELECTRIC-STARTING** Models, and "Off-Season" Savings now in effect.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ ZIP \_\_\_\_\_  
To: **COUNTRY HOME PRODUCTS®**, Dept. 2892F  
Meigs Road, P.O. Box 25, Vergennes, VT 05491



"I have been searching for years to find a reliable and cost-efficient way to keep our two-acre field clean and beautiful. The DR Field and Brush Mower is the answer!"  
- Richard A. Gustafson, Manchester, N.H.  
U.S. Govt. Purchasing GSA Contract #GS07F-8716D



Need  
to  
Change  
your  
address?

Call  
1-800-  
766-2149

**HISTORIC AIRCRAFT PAINTINGS.**  
Full color, laser printed, 11x14". Matted for framing. Choice: 36 WWI & WWII fighters & bombers. \$9.95 ea. / 4 for \$29.95. FREE catalog. Write: Robert Productions, Dept. A, P.O. Box 23485, Baltimore, MD 21203.



**MOONSHOT**  
THE GAME

From the Bell X-1 to the M2-F1.  
Moonshot The Game™ brings to life the epic adventure of America's race to the Moon!  
Featuring 180 card collector deck with digitally remastered NASA photography.  
Signed and numbered Limited First Edition available for \$34.95 + \$4.95 s/h.  
Call 1-888-240-4415 or visit [www.galacticattic.com](http://www.galacticattic.com)  
The Galactic Attic, P.O. Box 25396, Chattanooga, TN 37422-5396

**AIRLINER NUT? World's Largest**  
selection of airline and airliner related items: books, videos, models, calendars, shirts, posters, pins, magazines, etc. including our own **AIRLINERS**, The World's Airline Magazine. Call (800) 875-6711 or (305) 477-7163, fax (305) 599-1995 or write: AIRLINERS Catalog, PO Box 521238/AS, Miami, FL 33152-1238 USA for a free fully-illustrated catalog.

**KITES**  
FREE COLOR CATALOG  
Choose from over 200 exciting kites  
• Many unusual & innovative designs  
Call or write for your catalog today!  
Into The Wind • (800) 541-0314  
1408-K Pearl St., Boulder, CO 80302



## CALENDAR

### September 25-27

Reunion: 27th Air Transport Group, Ramada Inn, Warner Robins, GA, (602) 878-7007.

Reunion: U.S. Air Force Pilot Training Class 53-C, Colorado Springs, CO, (303) 797-0420.

### September 27

Biplane Fall Classic and Pancake Breakfast, Briscoe Field, Lawrenceville, GA, (770) 413-7112.

### September 27 & 28

Air Victory Museum Air Fair, South Jersey Regional Airport, Medford, NJ, (609) 267-4488.

Wings Over Houston Airshow Festival, Ellington Field, Houston, TX, (800) 4-HOUSTON.

### September 29-October 2

Reunion: Korean War Veterans, 13th Bomb Squadron, Radisson Hotel, Hampton, VA, (757) 595-3203.

### October 8-12

Reunion: Vietnam Veterans, 7th Air Force, Hampton, VA, (301) 277-0072.

### October 9-12

Reunion: Air Commando Association, Fort Walton Beach, FL, (904) 864-1953.

## CREDITS

**Cover.** Pam Francis, a Houston-based photographer, is grateful for the help of Dick Button, David Daniels, and Shawn Sprayberry, who deftly delivered the weighty spacesuit to her studio.

**Ghost Story.** O.H. Billmann, a resident of Simi Valley, California, is retired from the world of aviation.

**All That Jazz.** After 20 years as an advertising copywriter in New York, Arnold Benson has scraped by for the last 35 years as a freelancer, writing 46 paperback novels as well as short stories and articles for such publications as *Penthouse*, *Esquire*, *Reader's Digest*, and the *New York Times*.

**The Reconstruction.** William Triplett is a staff writer at *Capital Style*, a political

lifestyle monthly that premieres in October.

Illustrator David Povilaitis works out of a studio near Sonoma, California.

**Summer Hours.** Patricia Trenner, a lapsed pilot with some 200 hours, is senior editor at *Air & Space/Smithsonian*.

An 11-year *Air & Space* veteran, Caroline Sheen has also worked as a picture editor for National Geographic's books division and *Traveler* magazine.

**Spacesuit Saga: A Story in Many Parts.** Contributing editor Frank Kuznik is based in Cleveland, Ohio.

David Nance has been chronicling the manned spaceflight program since Gemini IV, and he says that photographing the launch of Apollo 11 in 1969 is one of his most cherished memories.

Breton Littlehales is a Washington, D.C.-based photographer.

**X-1: An Inside Look.** Barry DiGregorio's work has appeared in *Discovery*, *Aviation History*, and *Sky & Telescope*.

**X Marks the Spot.** The editors extend their thanks to Cheryl Gumm, deputy historian in the Air Force Flight Test Center history office at Edwards Air Force Base, and Tony Moore and Pete Merlin (see "The X-Hunters," Feb./Mar. 1995) for valuable research assistance.

Further reading: *Edwards Air Force Base*, Steve Pace, Motorbooks International, 1994.

*X-Planes at Edwards*, Steve Pace, Motorbooks International, 1995.

*Test Pilots: The Frontiersmen of Flight*, Richard P. Hallion, Smithsonian Institution Press, 1988.

*On the Frontier: Flight Research at Dryden 1946-1981*, Richard P. Hallion, NASA, 1984.

*Flights of Discovery: 50 Years at the NASA Dryden Flight Research Center*, Lane E. Wallace, NASA, 1996.

**Change of Command.** Ralph F. Wetterhahn flew fighters for both the Air Force and the Navy during the Vietnam war. Today he is a writer living in—and flying out of—Long Beach, California.

**The Making of Air Force One.** George C. Larson is the editor of *Air & Space*.

**Stakeout.** William E. Burrows, the author of *Deep Black*, has written a history of the Space Age, *This New Ocean*, which will be published next year by Random House.

**The English Connection.** Damond Benningfield is a freelance science and technology writer based in Austin, Texas.



## ON THE WEB SITE

# The Faking of Air Force One



Not just any Boeing 747, the First Family's airplane flies with dozens of modifications that make it unique. For their movie screen replica, Columbia Tristar Pictures copied most of those details. What are the many security measures and distinctive markings that make the real Air Force One one-of-a-kind? You can find out everything (that isn't classified) by visiting *Air & Space/Smithsonian's* Web site ([www.airspacemag.com/supp/AS97/AFOne.html](http://www.airspacemag.com/supp/AS97/AFOne.html)).

There's nothing quite like traveling by blimp. Take a tour of the cockpit and gondola through our latest QuickTime VR offering ([www.airspacemag.com/supp/AS97/blimp.html](http://www.airspacemag.com/supp/AS97/blimp.html)).

## Come Aboard the Spirit of Akron



## FORECAST

## In the Wings...

### SPECIAL ISSUE: Happy 50th, U.S. Air Force

#### The Long Arm of the Air Force

Meet the unsung heroes of military aviation.

#### Party On

Did you make it to the USAF's 50th anniversary celebration in Las Vegas last April? Don't worry. We got it all on film.

#### Commentary: An Airman's Career

Chief of Staff Ronald Fogleman reflects on the changes in the country's flying force over the last 50 years.



#### Songs Sung Blue

On Oscar Brand's recording of Air Force songs, there's a lot that's blue besides the wild yonder. The author makes the case that there's also a lot that's golden.

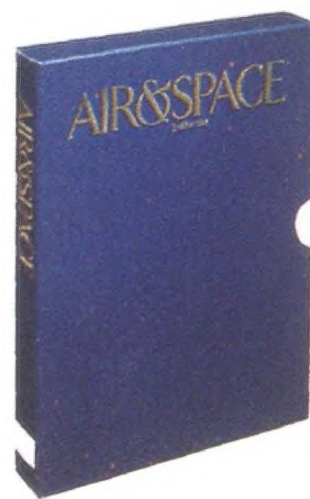
#### PLUS—Bonus Poster: 50 USAF Aircraft

Fighters, tankers, bombers, helos, observation craft—accompanied by a cargo hold-ful of vital statistics and historical information. All in flying colors.

## Now Available:

### Air & Space/Smithsonian Slipcases!

Collect and preserve your back issues of *Air & Space/Smithsonian* in these deluxe library cases. Each case is blue with gold embossing and holds six issues—a full year of *Air & Space*!



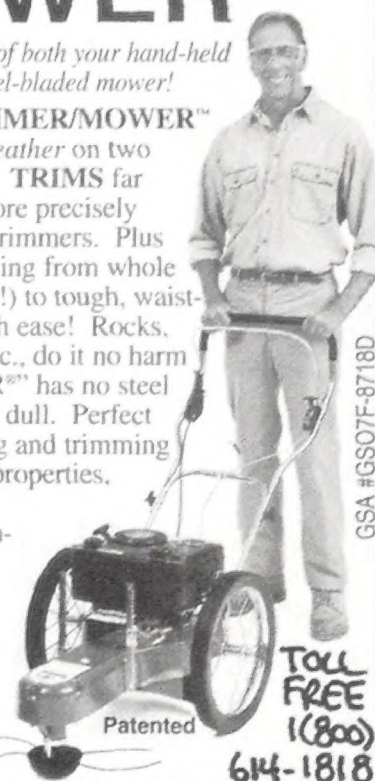
TO ORDER: Send \$7.95 per case (includes shipping and handling) to:

Cases  
*Air & Space/Smithsonian*  
901 D St. SW, 10th Floor  
Washington, DC 20024-2518

## Revolutionary "2-in-1" TRIMMER/MOWER™

Takes the place of both your hand-held trimmer and steel-bladed mower!

The DR® TRIMMER/MOWER™ rolls light as a feather on two BIG WHEELS! TRIMS far easier, better, more precisely than hand-held trimmers. Plus MOWS everything from whole lawns (even wet!) to tough, waist-high growth with ease! Rocks, roots, stumps, etc., do it no harm because the "DR" has no steel blade to bend or dull. Perfect for ALL mowing and trimming around smaller properties, vacation homes etc., or for finish-up mowing and trimming after riding mowers on larger parcels. A delight for anyone to use!



GSA #GS07F-8718D

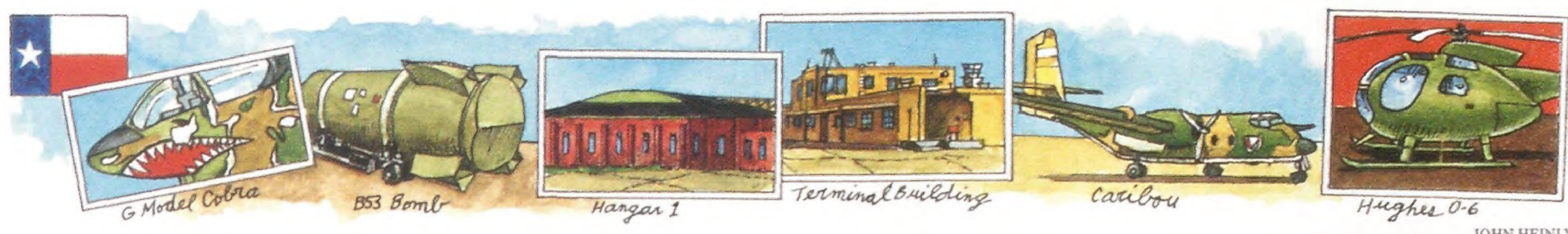
TOLL FREE  
1(800)  
614-1818

Please mail this coupon today for FREE DETAILS about the Revolutionary DR® TRIMMER/MOWER™ including prices of Manual and Electric-Starting Models, "Off-Season" Savings now in effect, and 30-Day Risk-Free Home Trial. There is no obligation.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ ZIP \_\_\_\_\_  
To: COUNTRY HOME PRODUCTS®, Dept. 2892  
Meigs Road, P.O. Box 25, Vergennes, VT 05491

© 1997 CHP, Inc.





JOHN HEINLY

# The English Connection

**I**n the middle part of the century, all sorts of folks passed through Amarillo, Texas. Some residents still recall what would happen whenever Howard Hughes would fly in to the town's English Field. "He'd call up at three o'clock in the morning—it might be four below zero outside—and demand that someone come down and take care of him," says Michael Thomas, operations director of the new English Field Air and Space Museum at Amarillo International Airport.

In those days, Amarillo was an important transcontinental waystation. Motorists appreciated the fact that it's the largest town on the stretch of Route 66—now I-40—between Oklahoma City and Albuquerque. And fliers liked the low fuel taxes they found at English Field (named for owner Harold English). The airport became a busy stopping point for Hughes' Transcontinental and Western Air. At its peak, English Field handled up to 35 TWA flights a day.

Amarillo's wide-open skies also appealed to the military. The Army Air Forces built a base in town that shared English Field's runways. Bell Helicopter operated a plant nearby, and outside city limits the Pantex plant assembled bombs for the nation's World War II effort.

In the 1960s the airlines introduced jets capable of long nonstop flights, and no longer needed to rely as much on Amarillo for transcontinental stopovers. But the airport still handled regional traffic, and in 1971 the city opened a new terminal. The old one was closed up, and the two hangars were rented out.

By the early 1990s the buildings stood empty. Michael Thomas drove out to the field in June 1996 and recalls that "the whole place was just a derelict." The floor of the red-brick Hangar 1 was cracked, windows were broken, and hundreds of pigeons roosted in the terminal.

But the buildings at English Field are slowly getting back in shape. Last February, Hangar 1 and the former general aviation building opened to the public as the first completed sections of

the English Field Air and Space Museum.

The museum's exhibits range from the commonplace—dozens of aircraft models and photographs—to the exotic, such as a prototype of the Viking Mars landers. Primarily, though, the museum focuses on the history of aviation in Amarillo. As an icy north wind rattles windows in the 68-year-old hangar and snow-laden clouds scud over the field, museum education director Don Watson, a retired U.S. Army colonel, easily recites the history of the museum's Vietnam-era choppers. To represent the town's Bell plant, there's an

---

*English Field Air and Space Museum,  
2014 English Rd., Amarillo, TX 79120.  
Phone (806) 335-1812 or 372-6999. Open  
Sun.–Fri.; noon–5 p.m.; Sat., 10 a.m.–  
5 p.m. Free admission.*

---

AH-1G HueyCobra attack helicopter, an OH-58 Kiowa observation craft, and an example of the ubiquitous UH-1 Iroquois, better known as a Huey. The museum also displays a Hughes OH-6 Cayuse observation chopper.

When Watson gets to the museum's North American QF-100D Super Sabre, he recounts watching it make its last flight. The green-and-orange airplane was serving as a drone at the White Sands Missile Range in New Mexico, where Watson was national range operations director. "It was flying a preset pattern and we were going to fire missiles at it," he recalls. But the drogue chute released unexpectedly, and the ground controllers were unable to get it to detach. Normally, Watson continues, he would have transmitted an order that would put the drone into a spin to make it crash out of harm's way. But this QF-100 had historic value—it was the last one in service—so he decided to let it try to glide in. "It landed out on the range, and when we picked it up it was full of sand but otherwise in good shape." Museum volunteers are still cleaning out the sand as they restore the jet to the appearance it

had as a fighter in the Vietnam war.

Other aircraft on display include a Grumman OV-1B Mohawk observation craft, used by NASA and the Army for testing at NASA's Langley Research Center in Virginia, and a wind tunnel test model of the Bell V-22 Osprey tilt rotor. The museum hopes to bring in several other military craft, among them an A-10 "Warthog," an F-15D Eagle, an F-16 Fighting Falcon, and an RF-4C—a McDonnell Phantom II fighter modified for reconnaissance (visitors interested in seeing a specific airplane should call before visiting).

At present, the only aircraft on the museum's 800,000 square feet of ramp space is a twin-engine de Havilland C-7 Caribou transport. But there are other reasons to wander outdoors: Visitors might catch a glimpse of Rockwell B-1B bombers from Dyess Air Force Base in Abilene practicing touch-and-go landings at the airport.

Besides aircraft, the museum documents locally produced examples of air weaponry—nuclear-bomb casings made at the Pantex plant. Some are sleek white daggers designed to take out tactical targets, while others are fat olive-drab behemoths that visitors often mistake for models of the atomic bombs that destroyed Hiroshima and Nagasaki in World War II. Also displayed is a Norden bombsight. When Hangar 2 opens this summer, bombs will form a substantial part of its exhibits.

After Hangar 2, the museum staff will start restoring the English Field terminal. The National Weather Service will help recreate the weather bureau office, and the ticketing area will house the original TWA ticket counter, complete with flight schedules, posters, and other period details.

And as visitors leave this reminder of a bygone era of air travel, they can cruise down the highway, taking in the neon motel signs and envisioning the days when Amarillo was a waystation for Howard Hughes—and the rest of America as well.

—Damond Benningfield



N O P L A C E L I K E H O M E



Smithsonian



©1990 Smithsonian Magazine • Printed on Recycled Paper • Illustration: Stephen D'Amico

### PLANET EARTH

A COMMEMORATIVE EARTH DAY POSTER FROM THE APRIL 1990 SMITHSONIAN

The Poster measures 21 $\frac{3}{4}$ " x 28 $\frac{3}{4}$ "  
Printed on Recycled Paper  
Allow 4 to 6 weeks for delivery

Send \$10.00 with address to:  
Smithsonian Magazine, P.O. Box 23624,  
Washington, D.C. 20026-0624



**WITH 190 HORSEPOWER,  
THERE'S A REASON  
WE PUT SCOTCHGARD™  
ON THE SEATS.**



Greg's fingernails dug deep into the steering wheel as his foot punched the accelerator.

A plume of dust billowed in his wake as his Chevy™ S-10® ZR2® charged along the old country road. Sure, its

optional V6 has enough horsepower to haul a mansion with 72 rooms and 48 1/2 baths. But, what fun would that be?

For information visit [www.chevrolet.com](http://www.chevrolet.com) or call 1-800-950-2438.



©1996 GM Corp. Buckle up, America!

**CHEVY S-10 LIKE A ROCK**

